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Assessing the Rehabilitation Needs of Foundations

A RESEARCH REPORT

Canada

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Assessing the Rehabilitation Needs of Foundations

A RESEARCH REPORT

A Literature Review on Foundation Problems and a Draft Diagnostic Guide for Basement Retrofit Contractors

Sponsored by the
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Saskatchewan Research Council
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ABSTRACT/RESUME

This report is concerned with the identification and rehabilitation of impaired foundations prior to retrofit. A literature survey has been conducted to discover if any of the available publications contain a reasonably full treatment of this topic, in a form that could be used by basement contractors. No suitable publication was found, though many contain relevant information. The relevant information has been drawn together and is presented in the form of a guide for contractors. This is presented in Appendix B in the form of a stand-alone document, designed to serve as a basis for an eventual publication. The report includes an annotated bibliography of 38 papers.

* * *

Le présent rapport porte sur le repérage et la restauration de fondations endommagées, avant l'exécution de travaux de réfection. L'auteur a examiné les publications existantes pour voir lesquelles traitent le sujet assez à fond et sous un angle pratique pour les entrepreneurs en réfection de sous-sols. il n'en a trouvé aucune, quoique beaucoup donnent des renseignements pertinents. Il a donc compilé les données sous forme d'un guide à l'intention des entrepreneurs. Inclus dans l'annexe B du présent rapport, celui-ci constitue un document autonome qui pourrait servir d'ébauche à une éventuelle publication. Le présent rapport comprend également une bibliographie annotée de 38 documents.

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This report is issued by the Buildings Energy Technology Transfer Program (BETT) of Energy, Mines and Resources Canada, in the belief that it usefully and significantly advances the state of the art. In doing this, BETT does not necessarily endorse the findings or views expressed herein.

The work in this report is part of a broader BETT plan to deliver to end users - in this case basement contractors - all the information and guidance they will need in the pursuit of their work. This overall plan is concerned primarily with the energy saving aspects of basement retrofit. But, as in many aspects of residential energy conservation, it is often difficult to separate new energy conservation practice from traditional building problems.

In basement retrofit there are two classes of problems that do not strictly belong to energy conservation but have a considerable impact on it. First, there is the generally-accepted fact that basements are particularly prone to problems of various types, which means that they rarely constitute a good starting point for quality retrofit work. Secondly, although a considerable range of techniques has been developed for dealing with basement problems, these have not been gathered together and set down on paper in the way that one would like. The work in this report consists of an attempt to remedy this situation.

At the outset, it was hoped that it might be possible to give basement retrofit contractors a simple guide, describing the various symptoms and defining the appropriate remedies. This has been achievable only in part; in many cases a basement problem may have a subtle range of causes, the diagnosis and rectification of which can be entrusted only to a

highly qualified specialist. This has two important consequences: first, it means that basement retrofit does not belong entirely in the hands of retrofit contractors; secondly, the involvement of specialists introduces matters of professional liability, with related cost increases on both counts. This could severely limit the number of houses in which all the conditions - economic, technical, etc. - are right for retrofit.

D. Eyre
Saskatchewan Research Council
January 1986.

The author wishes to thank the staffs of the Libraries of the Southern Alberta Institute of Technology, Calgary, the Saskatchewan Research Council, Saskatoon, and the Division of Building Research, National Research Council of Canada, Ottawa for their assistance in conducting the literature searches and in obtaining copies of literature not held in Canadian libraries.

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The Buildings Energy Technology Transfer Program (BETT) of Energy, Mines and Resources Canada is currently preparing a series of manuals dealing with various aspects of residential retrofit. The second manual in this series - namely "Techniques for Insulating Basements" - is devoted to basement retrofit, where there is considerable potential for energy conservation. It is estimated that more than 95% of Canada's houses and low-rise apartments have full basements. Heat losses from basements typically account for 10% to 30% of the total heat loss from dwelling units. With good retrofit techniques these losses can be reduced by as much as a factor of three.

Unfortunately, basement retrofit practice is not simply a matter of applying an energy conservation technique, no matter how well proven the technique may be. Some consideration must also be given to the existing condition of the basement. Basements - in fact foundations generally - are recognized as being one of the major sources of problems in the Canadian housing stock, and this has a profound effect on basement retrofit practice.

Historically, basements started out as deep foundation walls, giving firm structural support from below the frost penetration level. The contained space was used originally for large heating systems and fuel storage, but has rapidly evolved into a use-ful and popular living space. This evolution has proceeded ahead of the requisite building regulations and, as a result, the long-term integrity and performance of basements have usually failed to match that of the above-grade structures. For example: it is only since the mid-seventies that minimum standards of thermal performance of basement walls have been published, and these are still not universally adopted or enforced on new construction in Canada.

Basement and foundation problems have various causes, the most influential being the wide range of difficult conditions - both geologic and climatic - found throughout Canada. Other causes include poor design, poor construction practice and investment compromises which require service life to exceed only the first amortization period. The resulting problems range from periodic dampness, mustiness or flooding to major structural damage, and in many regions the problems may critically shorten the useful life of the house.

All this has important consequences for basement retrofit practice. In some cases the existing basement may be sound, allowing retrofit techniques to be applied with confidence. In other cases the basement may be sufficiently damaged to require rehabilitation before proceeding with retrofit. In extreme cases the basement may be so badly damaged that it would be inadvisable to proceed with any type of retrofit.

Conversely, retrofit practices change the environment of the basement structure and are therefore likely to have some effect on the long-term integrity of the basement. Recent work (Kani et al, 1985) indicates that basement retrofit may have a generally beneficial effect. But this does not exclude the potentially harmful effects of retrofit techniques that are poorly designed, poorly executed or poorly matched to the existing basement conditions. These can increase the vulnerability of the basement to structural damage; they can aggravate an existing problem or create a new problem where none previously existed.

In good retrofit practice all these factors must be taken into account. The practitioner must have a knowledge of retrofit practices, and must also know how to diagnose and rehabilitate a basement structure. Few practitioners have the skill to inspect a basement, identify its faults and understand their causes. Yet this is a necessary first step in the rehabilitation-retrofit process. The information is available but widely scattered across

many sources of varying authenticity. There is no single document to which the practitioner can turn for complete guidance on the diagnosis and remedy of basement problems.

It is the purpose of this report to overcome this problem by proposing a guide for use by retrofit contractors and home owners. Such a guide is useful in its own right, for contractors who are concerned solely with the rehabilitation of basements, but its primary purpose is to serve as a companion document to the forthcoming BETT manual entitled "Techniques for Insulating Basements".

This report is the end product of a study that was divided into two parts. The first part consisted of a review of the state of the art pertaining to the diagnosis and rehabilitation of defective foundations. Its objectives were as follows:

- To conduct a literature review and collect all relevant literature and information.
- To identify any publications which, with little modification, might serve as a guide on basement diagnosis and rehabilitation.
- Failing this, to assess each literature source in terms of its applicability to the proposed guide.
- To present the findings in the form of a brief state-of-the-art review and an annotated bibliography.

The objective of the second part of the study was to combine all the relevant information and prepare a diagnostic procedure for use by retrofit contractors (primarily) and home owners. The diagnostic procedure was to show, in a clear and understandable format, how to assess foundation conditions according to three categories:

- foundations that can be retrofitted safely without the need for rehabilitation work.
- foundations in which the deterioration is either minor or stabilized and need only minor rehabilitation before retrofit.
- foundations in which the deterioration is major, progressive or cyclic, and which require major rehabilitation as an essential precursor to retrofit.

The literature search was directed firstly at the libraries and collected publications of the following agencies:

- Southern Alberta Institute of Technology, Calgary, Alberta;
- The University of Calgary, Calgary, Alberta;
- Canadian Portland Cement Association, Edmonton, Alberta;
- Division of Building Research, National Research Council (DBR/NRC) - both in Ottawa and at the Prairie Regional Station in Saskatoon;
- Canadian Institute for Scientific and Technical Information, Ottawa, Ontario.

This was supplemented by on-line computer searches on eleven data bases, conducted with the assistance of library staff at Saskatchewan Research Council in Saskatoon, and at DBR/NRC in Ottawa.

Copies of pertinent literature were obtained from various sources above, and were also ordered from:

- Buildings Energy Technology Transfer Program, of Energy, Mines and Resources Canada (BETT/EMR), Ottawa, Ontario;
- Canadian Standards Association (CSA), Toronto, Ontario;
- Concrete Construction Publications Inc., Addison, Illinois;
- Earth Shelter Resource Center, Stillwater, Mn.
- Energy Conservation Branch of Alberta Energy and Natural Resources, Edmonton, Alberta;
- Housing and Urban Development Association of Canada (now the Canadian Home Builders Association), Toronto, Ontario;
- National Technical Information Service, Springfield, Va.
- Publications Section, DBR/NRC, Ottawa, Ontario;
- Publications Services Section, Ontario Ministry of Government Services, Toronto, Ontario.

During the literature review several Canadian experts were consulted either by telephone or in person. The names of these experts are given in the acknowledgements at the front of this report.

The most useful sources of information are listed as references. Twenty nine relevant publications have been issued by the Division of Building Research, National Research Council of Canada (DBR/NRC) and are listed as a group in the references. Thirty nine relevant publications have been identified from other sources and are referenced in the usual way.

In addition to references, this report also contains an Annotated Bibliography, which appears under Appendix A. The bibliography does not include the DBR/NRC publications, since these are usually small monographs dealing with particular topics, and are already highly condensed.

Much of the literature has been written to aid designers and owners in making decisions prior to construction, or to aid builders during initial construction (7, 38). This advice, if followed, would greatly reduce the need for future repairs and probably extend the economic service life of many foundations. Other than prescriptive instructions, prepared by the manufacturers of proprietary products, little helpful information has been published for contractors and others engaged in repairs and rehabilitation of foundations for residential buildings.

The literature published for the do-it-yourselfer varies greatly in quality and coverage (1, 2, 3, 5, 15, 28, 33).

Several good publications explain the nature of foundation problems, the causes of deterioration and concepts for design and construction for good performance - and are targetted at home owners, designers and contractors. Some of the referenced publications from the Division of Building Research (DBR/NRC) fall into this category and are widely

circulated to designers and builders. Other government and private publishers in Canada and abroad have produced useful information, which is identified in the bibliography.

Publications from other countries sometimes give the best coverage of a particular subject, but are not readily available throughout Canada. See for example the Department of the Environment Advisory Leaflets (12, 13, 14) and Edvardsen (16). Often authoritative research papers are not presented in a form suitable for the layman or practitioner (37) or are not translated into either of Canada's official languages (19). Some out-of-print articles are still the best on their subject or, at least, are of historical interest in recalling construction practices and standards of the past (20, 21).

Since retrofitting basements and crawl spaces for energy conservation is a relatively recent development in the evolution of residential construction practices, there are many uncertainties, untested and unproven theories, and techniques that require more investigation, research and development before definitive answers can be provided to some questions. Research and documentation of good and bad performance are needed (27). "There are also gaps in the technology available for home maintenance and repair" (26).

Simple tests and sound remedial advice are not easily found on some subjects (e.g. "How Dry Is Your Basement Floor: Building Practice Note 10). There is need for well written, short articles for the layman who seeks to understand the concepts and the options available to him. Equally, there is a need for comprehensive texts for designers (35), and manuals which will assist contractors in the assessment of existing conditions and the selection of the most appropriate remedial or upgrading measures. Pamphlets such as those issued by the Portland Cement Association (34) and the National Asociation of Home Builders (31) are useful, but need periodic updating. New concerns, such as sealing existing house basements against the infiltration of

radon gas, or selection of materials to avoid air quality problems in tightly sealed houses, must be addressed as quickly as possible after their identification. The whole subject of airtightness in house enclosures in general, and in basements in particular, is relatively new and requires research and reporting (18, 25, CBD 222).

The need for well-documented case histories of good and unsatisfactory performance is greatest during periods of innovation such as at present (22). New materials, methods and systems are frequently introduced with varying extent of performance testing. This is the case for waterproofing (4, 5, 6, 24, 30, 32), for draining (16) and for insulating (23). Excellent cautionary advice on how to prevent or control flooding of basements comes in a pamphlet to householders issued by Saskatchewan Government Insurance (36).

The main conclusion from the literature review is: that there is no single publication that might serve as a manual for the diagnosis and rehabilitation of foundation problems - either directly or with a small amount of modification. However, practically all of the referenced publications would be of assistance in producing such a manual, since they contain either necessary information or useful methods of arranging this information.

It should be noted that this study is directed at a diagnostic guide within the context of basement retrofit practices. A secondary conclusion of this review is that there is a need for a more comprehensive and detailed documentation of foundation problems and remedies, assembled under one cover and aimed at a broader spectrum of the building community.

5.1 Introduction

The proposed Guide is given in Appendix B, and is primarily intended to serve the needs of contractors who conduct retrofit work on basements. The intention is to alert them to the range of existing problems and recommended solutions. In particular, it is important that the contractor should know how to differentiate between:

- Basements that have no significant problems and that can be retrofitted with no significant risk;
- Basements that can be retrofitted provided that the right type of rehabilitation work is conducted first;
- Basements that are too deteriorated to justify either rehabilitation or retrofit.

5.2 The review process

The Guide, in its original draft form, was circulated to a number of agencies, technical experts and contractors known to be involved in the retrofit of basements (see the listing under Acknowledgements). Verbal and written comments on the draft were obtained in two ways:

- BETT staff in Ottawa circulated copies in-house, and to selected agencies and consultants.
- The author conducted group meetings and individual interviews with consultants and contractors in Winnipeg, Regina and Edmonton. For this part of the review, local contractors were approached through consultants. The consultants and contractors were asked to participate in group briefings, discussion meetings, individual interviews and submission of written comments.

At least 21 individuals and agencies read the draft, and written comments were received from 15. As far as possible, the draft was re-shaped to accommodate the most constructive written comments and to incorporate the many suggestions obtained during the interviews. It was felt to be inadvisable to print the reviewers' comments in this report, since they relate to the original Guide, which differs considerably from the final Guide presented on the following pages.

5.3 Content of the Guide

The Guide was originally conceived as being about two to three pages in length - the kind of thing that would fit in a contractor's pocket. The study has shown that this is unattainable; the range of problems and remedies is too large, even when the material is presented in a highly condensed form. It has therefore been decided to present all the essential information.

5.4 Recommendations concerning the Guide

It needs to be emphasized that the proposed Guide is not, in its present form, intended for direct circulation to contractors. Rather, it is designed to serve as a basis for a more polished publication, aimed at transferring the knowledge accurately and effectively to the end user. The Guide is therefore arranged as a stand-alone document in Appendix B.

At the same time, consideration should be given to the dual purpose of some of the information in the Guide. In some respects it serves as educational material; in other respects it could serve as a basis for control. It is recommended that insulation contractors be required to carry out a thorough examination of the basement/foundation before preparing estimates of costs. The Guide could be used as the basis for discussing and selecting the

options available to the homeowner for both rehabilitation and retrofit.

If this recommendation is accepted, then it might be useful to design a contract document, based on the Guide and used in combination with it. This would specify the agreed rehabilitation procedures and their costs, and would include spaces for the signatures of the two parties and the date of inspection. In this form it could serve as a basis for building permit applications and grant applications.

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38. White, Stanley. 1974. Leaking Basements - Prevention Is Better Than Cure! Concrete, Vol. 8, No. 8, pages 28 & 29.

In addition, the following relevant publications are available from the Publications Section, Division of Building Research, National Research Council of Canada, Ottawa, Ontario. K1A 0R6. (Note that some early publications may now be out of print.)

Canadian Building Digests

CBD 2 Efflorescence
CBD 3 Soil and Buildings
CBD 12 House Foundations
CBD 13 House Basements
CBD 16 Thermal Insulation in Dwellings
CBD 26 Ground Freezing and Frost Heaving
CBD 62 Trees and Buildings
CBD 84 Swelling and Shrinking Subsoils
CBD 128 Adfreezing and Frost Heavirg of Foundations
CBD 136 Concrete in Sulphate Environments
CBD 148 Foundation Movements
CBD 156 Drainage Around Buildings
CBD 161 Moisture and Thermal Considerations in Basement Walls
CBD 182 Frost Action and Foundations
CBD 184 Foundations on Swelling and Shrinking Subsoils
CBD 198 Flood-proofing of Buildings
CBD 222 Airtight Houses and Carbon Monoxide Poisoning
CBD 231 Moisture Problems in Houses
CBD 234 Wood Frame Foundations

Building Practice Notes

BPN 8 The Use of Vapour Barriers Under Concrete Slabs-on-Ground
BPN 10 How Dry is Your Basement Floor.

Building Research Notes

BRN 20 Soils in House Construction
BRN 21 Foundations for Houses
BRN 27 The Control of Moisture in Basements
BRN 31 Application of Interior Finish to Basement Walls
BRN 100 Fast Growing Trees Can Cause House Damage

Housing Notes

HN 8 Crawl Spaces: How to Avoid Trouble with the Foundation

HN 20 House Basements on Prairie Clays
HN 31 Heat Losses from House Basements

APPENDIX A

ANNOTATED BIBLIOGRAPHY

Title	Design Guide For Dry Basements In Existing Homes
Author(s)	Harry R. Abendroth AMAF Industries, Inc., Columbia, MD
Publisher/Date/Pages	U.S. Department of Housing and Urban Development, Office of Policy Development and Research, Washington D.C./ 1981/35 pages.
Available from/Price	National Technical Information Service Springfield, Va. 22161/Price Code A93/MF A01
Catalogue & Indexing Numbers	HUD-0002294 PB82-175928
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Methods available to homeowners to correct basement water problems are outlined. While some of the recommended measures would require a contractor's services, many can be taken by homeowners themselves. Conditions which contribute to wet basements include poor grading of ground adjacent to basement walls, the settlement of ground outside the basement walls, and defects or absence of gutters and downspouts. Other common problems include the improper care and use of outside hose faucets, below - grade windows and stairwells, settlement cracks in walls and floors, and undersized sump drains or sump pumps which are not working. Further problems include high underground water levels and defective or nonexistent underground drains. Solutions include adding surface fill, adding splashbacks or leader extenders to downspouts, caulking at floor and wall junctures and other joints, adding gravel to window wells, and improving ventilation or insulation to reduce condensation. Sump pumps, moisture or vapor barriers, and perimeter drains are also discussed.

cont...

Critique

This is a fairly comprehensive guide prepared for U.S. home owners and small contractors on how to correct basement water problems. Good explanations are given of: desirable surface drainage practices; subsurface water conditions and drainage systems; problem soils and methods of repairing and waterproofing leaking walls. Condensation in basements is discussed mainly as a problem of water dripping from cold pipes and accumulating on cool wall surfaces as is commonly experienced in warm, humid climates. The report contains no discussion of achieving air, vapour and water tightness essential for successful insulation of basements for energy conservation in cold climates. This manual, although neither widely circulated nor held in Canadian libraries, might be referenced in the proposed foundation repair manual.

Title	Exterior Basement Insulation, Booklet #2
Author(s)	Alberta Energy and Natural Resources, Energy Conservation Branch
Publisher/Date/Pages	Energy Conservation Branch, Alberta Energy and Natural Resources/Revised 1984/18 pages
Available from/Price	Energy Conservation Branch, Alberta Energy and Natural Resources, 2nd Floor, Highfield Place, 10010 - 106 Street, Edmonton, Alberta T5J 3L8/No charge within the province.
Catalogue & Indexing Numbers	ENR 1/17-No. 2 ISBN 0-86499-160-6
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

One of a series of publications encouraging home owners to retrofit their houses for energy conservation.

Critique

This is not intended as a manual for foundation repair contractors. It is written primarily as a guide for the do-it-yourselfer or handyman working on a house basement free of any serious structural or water problems. One cautionary paragraph on page 4 refers to such problems and the need for extensive improvements of drainage systems, complete outside excavation to the footing level, crack repairs and the desirability of insulating all the way down the exterior of the wall. The main advice of the pamphlet is to insulate vertically from above the main subfloor level to at least 300 mm below ground level and to provide a horizontal section of insulation to control lower wall heat loss. Materials, tools, and procedures are given from start to finish of a project. Short sections on wall preparation, sealing for air tightness, flashing covering external insulation and finishing the project appear to give sufficient detail to guide the average handyman through an uncomplicated retrofit. A companion publication "Basement Insulation" is recommended for those deciding to insulate on the interior. This could be referenced in a foundation repair manual or diagnostic sheet as a booklet of use to owners and small contractors in retrofitting basements with no structural or water leakage problems.

Title	Basement Insulation, Booklet #3
Author(s)	Alberta Energy and Natural Resources, Energy Conservation Branch
Publisher/Date/Pages	Energy Conservation Branch, Alberta Energy and Natural Resources/Revised 1984/14 pages
Available from/Price	Energy Conservation Branch, Alberta Energy and Natural Resources, 2nd Floor, Highfield Place, 10010 - 106 Street, Edmonton, Alberta T5J 3L8/No charge within the province.
Catalogue & Indexing Numbers	ENR 1/17-No.3 ISBN 0-86499-161-4
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

One of a series of publications on home energy conservation. A companion publication, "Exterior Basement Insulation" is also available as Booklet #2 in this series.

Critique

Like booklet #2, this is not intended as manual for repair and retrofitting of basements that have serious structural and water leakage problems. It is written with the presumption that the small contractor or do-it-yourselfer will be retrofitting a relatively dry and sound basement of cast-in-place concrete construction typical of most project houses built in western Canadian urban centres in the past 25 years. This could be referenced in a foundation repair manual or diagnostic sheet as booklet of use to owners and small contractors in retrofitting basements with no structural or water leakage problems.

Title	Underground Waterproofing
Author(s)	Brent Anderson
Publisher/Date/Pages	WEBCO Publishing, Inc., Stillwater, Minnesota/1983/66 pages
Available from/Price	Earth Shelter Resource Centre, 110 South Greeley, Stillwater, MN 55082 No. 5022 Paperback $9.50 U.S. Postpaid
Catalogue & Indexing Numbers	Library of Congress Catalogue Card Number 83-51145 ISBN 0-911117-01-6
Key Words	
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

Part One: Criteria for Selecting Waterproofing Systems presents: an introduction to waterproofing; positive and negative-side application; basics of concrete; sources of moisture - methods of control; and, judging waterproofing products.

Part Two: Waterproofing Details for Various Modes of Construction provides cross-sectional and perspective details and commentaries on 34 above- and below-grade waterproofing applications.

Part Three: Waterproofing Materials for Concrete, Masonry, and Wood identifies 21 generic waterproofing components, their application and performance in waterproofing systems for above-and/or below-grade structures.

Critique

Although apparently intended primarily to guide designers and contractors to successful waterproofing of new underground space structures, much of the information provided is of considerable reference value for experts considering approaches and materials for solving water problems in existing below-ground structures. Published in 1983, the references and interviews cited are current to 1982.

cont...

Critique continued... This is the most comprehensive and current handbook on U.S. practices and materials for underground waterproofing found in this search. Many parts of this manual provide source material suitable for the information and adaptation of experts and should be referenced and quoted in a foundation repair manual. Part Three with its comprehensive discussion of generic waterproofing components (many of which have been successfully introduced in the past 20 years), their application and performance in waterproofing systems will be of particular value in preparing a repair manual for house basements with serious water problems.

Title	Design Guide For Dry Basements In New Homes
Author(s)	Raymond W. Booth AMAF Industries, Inc., Columbia, MD.
Publisher/Date/Pages	Department of Housing and Urban Development, Office of Policy Development and Research, Washington, D.C./ 1981/28 pages + appendix.
Available from/Price	National Technical Information Service Springfield, Va. 22161/Price Code: PC A03/MF A01
Catalogue & Indexing Numbers	HUD 0002293 PB 82-175910
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This manual presents methods by which homebuilders can prevent leaks or moisture in basements without substantially increasing construction costs. The manual assumes a fundamental knowledge of residential construction. Aspects of surface water and groundwater and their impacts on home basements are explained, and the evaluation of a site and observations and steps to take during excavation are discussed. Concrete construction practices which minimize the occurrence of cracks in basement walls, floors, and joints are described. Construction techniques are described for footings; walls made of poured concrete, masonry block, and preserved wood; and floor slabs. General principles of waterproofing and dampproofing are outlined, with emphasis on the need to prevent both leakage and capillarity. The guide describes applied moistureproofing systems such as masonry cement - sand parging, bituminous coatings, bituminous membranes, elastromeric sheet systems, and fiberglass bonding. The installation of drainage systems using drain tile or perforated tubing is delineated.

cont...

Critique

This manual, intended for U.S. house builders, presents concepts and methods for waterproofing and dampproofing new homes during construction. It presents the essential elements for construction of dry basements of cast-in-place concrete, masonry block and preserved wood. Some of the products listed and procedures described are not widely used in Canada at the present time. Because the report is intended to guide builders of new basements, it does not contain suggestions on repair of cracked and leaking basements, although some of the information on moisture and waterproofing could be adapted in repairs to exterior of basements. The report contains no discussion of methods to achieve air and vapour tightness and to control internally generated moisture as are essential for successful insulation of basements for energy conservation in cold climates. Reference to this manual might be included in introductory sections of a comprehensive manual on foundation repair.

Title	30-Year-Old Army Base Homes Repaired, Thermally Upgraded
Author(s)	Canadian Building
Publisher/Date/Pages	Dow Chemical Canada Ltd./April 1984/1 page
Available from/Price	Dow Chemical Canada Ltd.
Catalogue & Indexing Numbers	
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This article describes repairing and insulating the exterior basement walls of 67 units of the permanent married quarters at Canadian Forces Base Gagetown, Oromocto, N.B. in the fall of 1983. Excavation was carried to the full length and depth of the foundation walls. New drainage pipes were installed, new damp-proofing, and polystyrene insulation boards having a thermal resistance of RSI 1.74 were fastened to the basement walls with large headed concrete nails and fiber washers. Pre-treated wood nailer strips were installed to accommodate the aluminum drip caps and along with framing of windows and at corners was used to support the 0.7 mm thick pre-painted aluminum sheeting and flashing used to cover the insulation above grade and to a depth of 150 mm below grade. Some 90,000 board-feet of insulation was used in this contract which cost a total of $410,000.

Critique

This provides an interesting record of a relatively large basement repair and retrofit contract. More construction details and a commentary on monitored performance over the next few years would be a valuable contribution to the literature and should be included in a manual of foundation repairs.

Title	Concrete Construction For Housing And Small Buildings
Author(s)	Canadian Standards Association
Publisher/Date/Pages	Canadian Standards Association, Rexdale, Ontario/March 1983/ 29 pages
Available from/Price	Canadian Standards Association, 178 Rexdale Boulevard, Rexdale, Ontario, Canada M9W 1R3
Catalogue & Indexing Numbers	ISSN 0317-7874 CSA Standard A438-M1983
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

The Standard specifies physical requirements for concrete, and the construction requirements for handling, depositing, consolidating, finishing and curing concrete used in footings, foundation walls, slabs on ground, driveways, walkways, patios, steps, and parking areas. The requirements for the concrete materials are covered by CSA Standard CAN3-A23.1, Concrete Materials and Methods of Concrete Construction. The construction requirements of CAN3-A23.1 require a level of quality that in practice is seldom achieved in the construction of housing and small buildings. The need for a new standard arose as a result of builder's surveys carried out by HUDAC and others that indicated that builders were experiencing major problems with cracking and leakage in basement walls, as well as cracking, dusting and scaling of other concrete work. The major cause of these problems was attributed to poor concreting practices.

Critique

This Standard provides requirements to control the quality of cast-in-place construction that forms part of, or is associated with, the construction of housing and small buildings as defined by Part 9 of the National Building Code of Canada. Appendix D, Waterproofing and Dampproofing is taken verbatim from the National Building Code 1980,

cont...

Critique continued... Section 9.13. Although this standard is intended for new construction, and makes no reference to repairing or retrofitting existing buildings, it is a useful reference document for those considering repairs prior to retrofitting for energy conservation because it contains references to other related standards for dampproofing and waterproofing materials and, because certain jurisdictions may require retrofitting to meet the standards for new construction.

Title	Repair of Concrete
Author(s)	
Publisher/Dage/Pages	Concrete Construction Publications, Inc./not dated/35 pages
Available from/Price	World of Concrete Centre, 426 S. Westgate, Addison, Illinois 60101/$6.00 U.S.
Catalogue & Indexing Numbers	
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

The editors of Concrete Construction have compiled this guide to repair of concrete from their Concrete Construction Problem Clinic files. 101 problems are discussed in question-and-answer format and collected alphabetically into the 19 repair techniques: acid etching and wash; bonding; cleaning, removing stains and discoloration; crack and joint repairing; evaluating damage; grooving and grinding; grouting; leveling; liquid floor hardening; overlaying; painting, coating and lining; patching; plastering; resurfacing; sawing, drilling and cutting; shotcreting; slabjacking; underwater repairing; waterproofing.

Critique

In their introduction to the booklet the publishers state: "While there is a wealth of information in this issue, it should be noted that the 101 items included have been assembled by culling from the extensive Concrete Construction Problem Clinic files; the result is that this issue is by no means a complete treatment of the subject of repair, although an attempt has been made to cover as many repair techniques as we could find in our voluminous collection".

This could not be considered to be a repair manual for basements but some of the following sections would be useful references in preparing a foundation repair manual: 10. Footing Problem; 29. Sealing floor cracks against leakage; 30. Foundation wall repair; 60. Repairing an imperfect wall; 62. Dry packing; 69. Pyrites, popouts and rust stains; 98. Damp, flooded basement; 99. Seepage in basement wall; 100. Moist spot in floor.

Title	Concrete Repair: Materials and Methods
Author(s)	
Publisher/Date/Pages	Concrete Construction Publications/July 1982/54 pages
Available from/Price	Concrete Construction Publications, Inc. World of Concrete Centre 426 S. Westgate, Addison, Illinois 60101/$9.00 U.S.
Catalogue & Indexing Numbers	
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This collection of reprints from Concrete Construction Magazine covers the topics: "Identifying concrete deterioration"; "Basic concrete repair"; "Getting ready for concrete repairs"; "Surface preparation of concrete for paints and coatings"; "Repair techniques and materials"; "Epoxies for concrete repair and restoration"; "Patching concrete with rapid-setting materials"; "The Iowa method of bridge deck resurfacing"; "If the wall leaks, here's how to repair it effectively and permanently"; "Shotcrete for building repairs"; "Steel corrosion damage on vertical concrete surfaces, Part I"; "Steel corrosion damage on vertical concrete surfaces, Part II"; "Agents that attack concrete".

Critique

Repair of leaking basement walls with epoxy is discussed in the article: "If the wall leaks, here's how to repair it effectively and permanently". A "Selection guide to repair techniques and materials" and a "Guide to effect on concrete of substances embedded in or in contact with concrete" and, pictorial identification of concrete deterioration types and description of causes are among the sections in this booklet that should be reviewed in preparation of a foundation repair manual.

Title	Waterproofing and Dampproofing Concrete
Author(s)	
Publisher/Date/Pages	Concrete Construction Publications/March 1983/48 pages
Available from/Price	Concrete Construction Publications, Inc. World of Concrete Centre 426 S. Westgate, Addison, Illinois 60101/$9.00 U.S.
Catalogue & Indexing Numbers	
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

These articles reprinted from Concrete Construction magazine show how to waterproof and dampproof many concrete projects. Includes applications like repairing leaking swimming pools and waterproofing or dampproofing walls and roofs with sprays, sheets and coatings. Describes the best ways to choose the appropriate material, establish a barrier, and repair wall cracks. Also discusses waterproofing procedures and materials for the earth sheltered construction contractor.

Critique

Most of the articles in this booklet apply to the design and construction of below ground structures. Some of the articles such as "Keeping the house dry" and "NAHB looks into basement water leakage problems" provide some background information for possible future reference in preparing a foundation repair manual. The last two articles: "If the wall leaks, here's how to repair it effectively and permanently"*and, "Simplified repair of wall cracks" present pictorial descriptions, list of tools and materials needed, and procedures for injection of epoxy resin to repair leaking cracks in concrete walls.

*Also included in "Concrete Repair: Materials and Methods", July 1982.

Title	Cracks in Concrete: Causes and Prevention
Author(s)	
Publisher/Date/Pages	Concrete Construction Publications/updated 1984/40 pages
Available from/Price	Concrete Construction Publications, Inc. 426 S. Westgate, Addison, Illinois, 60101/$6.00 U.S.
Catalogue & Indexing Numbers	
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Fourteen articles have been reprinted from Concrete Construction Magazine issues between 1960 and 1981. In addition to explaining the causes of cracking in concrete, the different kinds of cracks that occur, and ways to prevent them, it presents questions and answers on shrinkage, pavement faults and how to prevent them, causes of cracks in slabs and columns and, effects of temperature gradients.

Critique

Apart from explanations of the processes and causes of cracking there is little of direct reference value in this booklet for the preparation of a basement repair manual.

Title	Dampness in Buildings Advisory Leaflet No. 47
Author(s)	Department of the Environment Ministry of Public Building and Works
Publisher/Date/Pages	Her Majesty's Stationery Office/1967/3 leaves
Available from/Price	49 High Holborn, London W.C.I./6d net
Catalogue & Indexing Numbers	UDC 699.82
Key Words	
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

Try to find the true cause of the dampness before spending money on remedial work. Sometimes more than one type of dampness are present at the same time. Condensation can be difficult to distinguish from rain penetration while at times rain penetration may seem to be rising damp.

Dampness can remain for months after the cause has been found and the defect remedied. Many soils contain hygroscopic (moisture attracting) salts and rising damp can carry them up into walls and floors. These salts may cause damp patches whenever the air is moist (through weather conditions - or cooking and washing) even though the rising damp has been stopped. The salts can go through the plaster to show as efflorescence on the inner surface. Affected surfaces must be cleaned with a dry brush and the final decoration put off until the dampness has completely dried out.

Critique

Although no advice is given on remedying dampness in basements, it is with respect to concrete ground floors on subgrade and timber floors over crawl spaces. References are made to other advisory leaflets in the series. The format of this document will be of interest in preparation of a diagnostic sheet on basement evaluation and repairs required before insulation retrofitting.

Title	Watertight Basements Part 1 Advisory Leaflet No. 51
Author(s)	Department of the Environment Ministry of Public Building and Works
Publisher/Date/Pages	Her Majesty's Stationery Office/1970/3 leaves
Available from/Price	British Standards Institution 101 - 113 Pentonville Road, London, England N19ND/9d[4P] net
Catalogue & Indexing Numbers	UDC 643:8,699.82 DISTI 69.021.16 Bldg.
Key Words	
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

To construct a completely watertight basement or cellar has always been regarded as difficult.

Concrete when properly made is an ideal material for watertight construction without asphalt tanking or a waterproof membrane, but it is not always possible to make an underground structure watertight at the first attempt. Even if it seems watertight to start with leaks may appear later. These may be due to rising groundwater, the sump effect of the excavation, cracking from shrinkage or unequal settlement.

The principle behind the advice given in this leaflet is that because all parts of the basement floor and walls are accessible, the position of any leak can be easily detected. It can then be repaired by pressure grouting - see Leaflet No. 52 in this series.

Concrete basements without asphalt tanking or a waterproof membrane although watertight are not vapour-proof.

Critique

A useful reference on the design and construction of watertight basements referring to British standards and practices, which gives excellent advice for new construction and useful background information for preparation of a foundation repair manual.

Title	Watertight Basements Part 2 Pressure Grouting Leaking Basements Advisory Leaflet No. 52
Author(s)	Department of the Environment Ministry of Public Building and Works
Publisher/Date/Pages	Her Majesty's Stationery Office/1971/3 leaves
Available from/Price	British Standards Institution 101 - 113 Pentonville Road, London, England, N19ND/4p net
Catalogue & Indexing Numbers	UDC 643.8, 69.059.25 CISTI 69.021.16:Bldg.
Key Words	
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

This method applies to basements built in watertight concrete construction (see leaflet 51). Such basements do not incorporate a waterproof membrane; the floor is laid without a screed or other finish-and the walls are not rendered or plastered. Because all parts of the floor and walls are accessible, the position of any leak can usually be easily detected. It can then be repaired by drilling holes at or along the leak, inserting temporary steel tubes, and pumping grout through to seal the leak.

Critique

A useful reference on pressure grouting for preparation of a foundation repair manual.

Title	Weatherizing Your Home
Author(s)	George R. Drake
Publisher/Date/Pages	Reston Publishing Co./1978/381 pages
Available from/Price	Reston Publishing Company, Inc. A Prentice-Hall Company Reston, Virginia 22090 $16.95
Catalogue & Indexing Numbers	ISBN 0-8359-8592-X TH 1715.D7 643'.7 78-17165
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This book contains detailed information and step-by-step instructions to enable the U.S. home owner to weatherize his home.

Critique

A short note (less than one page) entitled Cracks in the Foundation (page 59) includes a procedure for Do-It-Yourself Repairing Foundations. The procedure is given for repairing dry cracks and holes, and leaking holes, and is preceded by lists of materials and tools needed for the work. The format is simple, the instructions are minimal but sufficient for the layman, and the author avoids the use of proprietary product names through the use of common generic names. This format might be considered if a section of foundation repair manual is to be directed to the layman do-it-yourselfer.

Title	New Method of Drainage of Basement Walls
Author(s)	Knut I. Edvardsen; D.A. Sinclair (translator)
Publisher/Date/Pages	National Research Council of Canada Technical Translation No. 1603/1972/15 pages
Available from/Price	National Research Council of Canada Ottawa, Ontario
Catalogue & Indexing Numbers	TT-1603 Translation (Division of Building Research) No. 207
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

The traditional practices employed in designing and installing peripheral drainage systems around subgrade constructions have not been entirely successful, particularly where the basement space is to be finished. The Division of Building Research became aware of the development of improved practices in the Scandinavian countries. This is a translation of a study of these new approaches carried out by the Norwegian Building Research Institute which have particular application in Canada.

Critique

Unconventional methods for protecting basement walls are presented. Glass wool was investigated as a "draining and capillary-disrupting layer" on the outside of a basement wall and found in laboratory tests to be suitable provided that the foundation tile drainage system was functioning properly also. Other external drainage methods mentioned are: corrugated slabs of asbestos cement; plastic panels with projecting knobs or ridges to provide clearance from the foundation wall; and, combinations of the above. Although not referring to foundation repair, the concepts of drainage permitting drying out of wet masonry or concrete walls are of interest in retrofitting and repairing wet basements.

Title	New Basement Wall Designs For Below-Grade Living Space
Author(s)	A. Elmroth and I. Hoglund; H.R. Hayes (translator)
Publisher/Date/Pages	National Research Council of Canada Technical Translation No. 1801/1975/44 pages
Available from/Price	National Research Council of Canada Canada Institute for Scientific and Technical Information Ottawa, Ontario
Catalogue & Indexing Numbers	TT-1801 Translation (Division of Building Research) No. 217
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

The increasing utilization of house basements for habitable space and the consequent desirability of improved performance of such subgrade structures are factors common to both Canada and the Scandinavian countries. This translation describes work in Sweden in which mineral fibre insulation is utilized on the outside of basement walls to provide both a drainage layer and thermal insulation.

Critique

The authors present new methods of providing moisture protection to external basement walls, conventional Swedish methods and results of laboratory and field tests on mineral wool insulation batts applied to the outside of basement walls. The authors conclude that the external insulation method has advantages in both drying out wet masonry walls, in protecting walls from water penetration and in providing insulation for energy conservation. Although not referring directly to foundation repair, the concepts presented are of interest in retrofitting and rehabilitating wet basements.

Title	Air-Vapour Barriers
Author(s)	D. Eyre and D. Jennings
Publisher/Date/Pages	Buildings Energy Technology Transfer Program Energy Conservation and Oil Substitution Branch Fourth Edition/January 1983/84 pages
Available from/Price	Regional Conservation and Renewable Energy Offices of Energy, Mines and Resources Canada
Catalogue & Indexing Numbers	ISBN Ø-662-13Ø16-2
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Critique

A section on Problems with Concrete Basements, pages 65 and 66, explores undesirable conditions that could be set up in the concealed space between a concrete basement wall and the vapour barrier on the warm side of the interior basement insulation. Three solutions are discussed. Highest technical merit is given for achieving continuity of the air-vapour barrier for external basement insulation.

Title	Damp-proofing Problems in Cellar Masonry Dichtvngs probleme bei Keller muaerwerk (German Text)
Author(s)	F. Haferland
Publisher/Date/Pages	Deutsche Bauzeitung/No. 12, Dec. 1983/pp. 45-48
Available from/Price	CISTI (DBR) Access. Number 146569 UP:8402
Catalogue & Indexing Numbers	UC: 69.021; 699.82
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Changing the use of cellar rooms from food stores to hobby rooms etc. requires improved damp-proofing. The author describes the design mistakes in the foundations and cellar walls of his own house, which resulted in dampness appearing within a year of construction, together with the expensive remedial measures necessary.

Critique

German text limits usefulness of this reference in preparation of a foundation repair manual.

Title	Basements
Author(s)	R.A. Jones, W.H. Kapple, J.T. Lendrum
Publisher/Date/Pages	Small Homes Council, University of Illinois Circular Series F2.0, University of Illinois Bulletin, Volume 51, Number 22; November, 1953/8 pages
Available from/Price	CISTI NTIS
Catalogue & Indexing Numbers	CISTI 69.021
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This bulletin published in 1953 is still a good guide for designers, contractors, building tradesmen and owners on the principles of design and construction of basements for single family houses in areas and conditions similar to the U.S. midwest. It does not cover the structural design of the footings or the foundation, nor does it treat special soil conditions. It does provide good advice on: access; daylighting; keeping the basement dry - free from moisture condensation, leaks and water seepage; soil and drainage determine construction; recommendations for basement construction; and, repair of basement leaks.

Critique

Page 8 of this bulletin provides excellent advice on how to repair basement leaks due to water pressure against walls or under the floor and how to handle back-up water from sewer or drain lines. Control of condensation on internal wall and pipe surfaces is discussed on page 4 mainly for humid summer air conditions. A short section on insulating basement walls discusses waterproofing the interior surface of the foundation wall, using pressure treated furring strips to prevent decay, selection of "moisture resistant insulation", and using vapour-barriers and care in construction to insure moisture does not get behind the insulation. This pamphlet might be referenced in introductory and historical sections of a comprehensive manual on foundation repair.

Title	Crawl Space Houses
Author(s)	Rudard A. Jones, A.I.A.
Publisher/Date/Pages	Small Homes Council, University of Illinois/1959/6 pages
Available from/Price	CISTI 69.021.1 NTIS
Catalogue & Indexing Numbers	Circular Series F4.4, University of Illinois Bulletin Vol. 56, Number 39; January, 1959/6 pages
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This bulletin published in 1959 provides excellent guidance for designers, contractors, building tradesmen and owners on: how to build dry crawl spaces; warm floors over open or closed crawl spaces, heating systems, insulation of floors and walls, construction details and termite control.

Critique

The basic recommendations of this bulletin still apply for this type of construction today. Crawl spaces are not recommended in areas of high groundwater or periodic surface flooding. Exterior and interior grading and drainage systems are described. Control of moisture from the house into the crawl space can be achieved by providing a vapour barrier between the sub-floor and finish flooring and sealing all openings and penetrations. Rising ground moisture can be controlled with a vapour-barrier type of ground cover which is not susceptible to damage by fungi and by providing adequate ventilation and circulation for freshness and dryness. This pamphlet might be referenced in introductory and historical sections of a comprehensive manual on foundation repair.

Title	Effects of Insulation on Basement Walls
Author(s)	Kani M., Timusk J., Pressnail K.D., Scheuneman E., Tremayne M., Eyre D. (Editor).
Publisher/Date/Pages	Buildings Energy Technology Transfer Program (EMR)/ October 1985/39 pages + 8 appendices.
Available from/Price	The BETT Program, Energy, Mines and Resources Canada 580 Booth Street, Ottawa, Ontario K1A 0E4
Catalogue & Indexing Numbers	BETT Publication No. 85.03
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

A survey has been conducted to determine the incidence of foundation problems caused by foundation retrofit, and to determine the types of problems that are occurring. The findings are based on the responses of 148 municipal building officials and 102 specialists in this field, and are supported by supplementary studies dealing with the statistics of retrofitted basements and the state of the art relating to foundation problems. The incidence of retrofit-induced foundation failure is very low, in fact lower than the incidence of foundation problems arising from conventional construction practise. Within this low incidence, two main types of problems were found to be significant: the first consists of potential moisture problems at the top of foundation walls; the second consists of structural problems caused indirectly by frost heave under adjacent unheated garages. There is no significant evidence of foundation problems resulting from the direct effects of frost heave and adfreezing.

continued....

Critique

This report will be an important source of background information in preparing a foundation repair manual.

In spite of the opinions of many of those surveyed that many retrofitted houses are experiencing problems, only four well documented cases of damage to residential foundations in four Ontario cities were obtained. A number of other less well documented cases were found in other Ontario cities. In December 1983 the Ontario Building Code Branch issued a note requiring the use of non-frost-susceptible soils for backfill.

Title	The Place To Insulate
Author(s)	Kathy Kukula
Publisher/Date/Pages	Rodale's New Shelter/September 1983/4 pages
Available from/Price	Rodale Press Inc., 33E. Minor St. Emmaus, PA, USA, 18049
Catalogue & Indexing Numbers	ISSN 0195-6582
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Critique

This is a short magazine article which encourages U.S. home owners to insulate the outside of concrete foundation walls. Insulations, adhesives and coverings and U.S. source list by trade name are given. Some of these products are not generally available in Canada. The quoted annual heat savings have been calculated for electrically heated houses in 6400 degree (F)-day climate at unit electricity costs considerably higher than in much of Canada.

Title	Waterproofing Methods And Products
Author(s)	Charles A. Lane
Publisher/Date/Pages	Earth Shelter Living/March-April 1984/pages 23-27 inclusive
Available from/Price	
Catalogue & Indexing Numbers	
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Selecting the proper waterproofing material and correctly applying it to an earth sheltered structure is discussed under the following subheadings: water drainage, waterproofing skin, criteria for choosing, the major systems, butyl rubber, EPDM membranes, modified bitumens, bentonite. In conclusion the author reviews the steps to waterproofing an earth sheltered structure.

Critique

This author presents three 'petrochemical' and one clay mineral products as the best suited for use in waterproofing earth sheltered structures. He poses questions and offers answers to illustrate the factors which a designer should consider in developing design criteria and selecting appropriate waterproofing systems for application to particular structures. Although much less comprehensive in the range of materials discussed than the book "Underground Waterproofing" by Brent Anderson published in 1983, this article does present additional information and commentary of value to designers and contractors faced with difficult waterproofing problems. It should be referenced as a source for experts in the proposed foundation repair manual.

Title	Air Sealing Homes For Energy Conservation Second Draft
Author(s)	Marbek Resource Consultants
Publisher/Date/Pages	Buildings Energy Technology Transfer Program, 1984 Energy Conservation and Oil Substitution Branch
Available from/Price	Energy, Mines and Resources Canada, Ottawa, Ontario
Catalogue & Indexing Numbers	ISBN 0-662-13053-7 Catalogue Number M92-6/1984 E
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This manual describes the air sealing of existing houses through the application of sealants, weather stripping, air-vapour barriers, other products and techniques. It is divided into three sections: I. The Principles of Air Sealing; II. Assessment Procedures; and III. Air Sealing Practices. The manual also contains a draft glossary of terms; appendices containing data sheets on various sealants and weather stripping materials; and a feedback form for comments from readers.

Critique

From introduction to principles of air sealing, through fundamentals of air exchange, air quality and the effects of sealing, introduction to air sealing practices, materials and their application, foundations, and floors over unheated spaces and numerous related worksheets such as Worksheet I: Procedures for sealing foundation cracks, there is much source material that should be included in a foundation repair manual.

Title	Housing Conservation Technology Executive Summary And Recommendations
Author(s)	F. Eugene Metz, Harvey W. Berger and Thomas H. Boone
Publisher/Date/Pages	Department of Housing and Urban Development, Washington, D.C., Office of Policy Development and Research/July 1977/33 pages
Available from/Price	National Technical Information Service Springfield, Va. 22161 Price Code: PC A03/MF A 01
Catalogue & Indexing Numbers	HUD-0000363 PB80-135684
Key Words	Residential buildings/technology assessment/insulation/ waterproofing/renovating/plumbing/settlement (structural)/ energy conservation
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

American homeowners often do an inadequate job of conserving their dwellings because they do not know what should be done and because current technologies often cannot be used by do-it-yourselfers. There are also gaps in the technology available for home maintenance and repair. A series of tables evaluate current technology for 11 critical building elements, plus repair and renovation technology as a whole. These tables summarize the skills needed for use of the technique, the means of installation, and advantages and disadvantages. Topics covered are roofing, exterior cladding, windows, insulation, basement waterproofing, floor and wall underlayments (wet areas), structural framing, heating and cooling systems, plumbing systems, electrical systems, and appliances. Technologies which will enable the homeowner to quickly measure the moisture accumulating under the roof or to evaluate the quality of the home's wiring do not exist; better waterproofing materials are also needed for basements and other wet areas. Little information is available on the durability of various exterior products and window frame security has received little attention. Insulation technology is in a state of flux. Here the homeowner especially

cont...

Abstract continued... needs full information to make an informed decision. Renovation involves special problems because old houses were frequently built out of plumb and settling adds to the problems encountered in using prefabricated materials. Do-it-yourselfers are often the first to use technology; however, conservative lenders and housing codes often hinder such innovation.

Critique This report presents a summary of technical findings extensively presented in a companion report of the same title. The reader is directed to the companion report for more detailed information on current U.S. technology associated with the repair, replacement, and renovation of building elements, economic decision making, constraints to technical innovation and other subjects covered in both reports. General comments on the limited make-up and capabilities of the home improvement, rehabilitation and renovation trades in the U.S.A. seem applicable also to the Canadian scene related to basement repairs and retrofitting services. Of the eleven critical building elements identified and examined in this study, the sections 4) Insulation and 5) Basement Waterproofing, contain little information of direct interest in this search for literature on basement repairs prior to insulation retrofitting. No comments on insulation materials or techniques suitable for basements are included. Under Basement Waterproofing, sprayed or trowelled glass fiber reinforced cement coating was the only material listed and was assessed as having high bonding strength, but no performance data was available at the time of writing with respect to its use in Basement Waterproofing applications. Although neither widely circulated nor held in Canadian libraries, this report might be referenced in introductory sections of a comprehensive manual on foundation repairs.

Title	Energy Conservation and House Basements A Research Report
Author(s)	Middleton Associates, Toronto, Ontario
Publisher/Date/Pages	Prepared for the Energy Conservation and Oil Substitution Branch, Energy, Mines and Resources Canada/October 1982/ 143 pages
Available from/Price	The Buildings Energy Technology Transfer Program Energy, Mines and Resources Canada 580 Booth Street, Ottawa, Ontario K1A 0E4
Catalogue & Indexing Numbers	BETT Publication No. 82.01
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This report is the end product of a state-of-the-art study on the effects of energy conservation measures on basements in low-rise residences. The report reviews the various types of basement construction, together with their associated structural problems. There is also a review of the various soil and water mechanisms that can lead to structural damage of basements. The options of interior and exterior insulation are discussed for various basement conditions. The report concludes with a general review of the areas that require further study and includes an annotated bibliography of 55 cited references.

Critique

This report is the first step in a planned R & D thrust on basement retrofit technology. It fulfills the need to review the state-of-the-art in 1982, as a basis for determining future R & D strategies. It's coverage is broad and sufficiently deep to indicate several areas where uncertainties exist and where more research is needed. It should not be used as a manual of good, proven practice but rather, regarded as a good introductory text for those who wish to familiarize themselves with the main issues in this complex field.

Title	The Basement Book
Author(s)	Harris Mitchell
Publisher/Date/Pages	Personal Library, Publishers, Toronto/1982/105 pages
Available from/Price	Distributed in Canada by: John Wiley & Sons Canada Ltd. 22 Worchester Road, Rexdale, Ontario M9W 1L1 Distributed in United States by: Everest House, P.O. Box 978, 424 Raritan Centre, Edison, New Jersey 08817
Catalogue & Indexing Numbers	ISBN 0-920510-48-5 TH 3000.M57 643'.5 C81-094944-X
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Critique

The merits of this attractive book lie mainly in its introductory and generalized approach for home handymen and owners contemplating finishing basement space. Written in layman's terms, it is extensively illustrated with photos and drawings. Directions are given in prescriptive form and reference is made to proprietary products which can be readily identified in retail hardware and building material outlets. At least minimal coverage is given to the whole spectrum from planning through finishing and equipping basement space. Unfortunately the treatment of the technical aspects of problems with water and correct procedures in installing dampproofing waterproofing, air and vapour barriers and insulation may not be sufficient to guide the non-expert handymen or do-it-yourselfers to adequate solutions or, to forewarn and equip them to select and deal with contractors offering specialized services in these subjects.

cont...

Critique continued... In the context of this literature search, the book would not be considered a manual for foundation repair contractors. One or two photographs of repairing cracks on the outside of basement walls are the best found on this subject to date and might be useful in such a manual if permission from the author and publisher could be obtained. None of the contents of this book would likely be used in preparation of a diagnostic sheet for contractors to assess foundation condition and determine repair required prior to insulating.

Title	New Life For An Old House
Author(s)	Harris Mitchell
Publisher/Date/Pages	Canada Mortgage and Housing Corporation/December 1982/ 63 pages
Available from/Price	Canada Mortgage and Housing Corporation/Free of charge
Catalogue & Indexing Numbers	NHA 5628 12/82
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This booklet is intended as a guide to assist homeowners in identifying, understanding, and repairing many of the common problems that may occur in a home.

Critique

The author introduces the section on The Basement with the following statement.

"A basement doesn't require much maintenance work, but it is a good place to spot potential problems. You can learn more about the condition of an old house from the basement than anywhere else. Many of the troubles that occur elsewhere have their origins here - in cracked foundations, weakened timbers, poor drainage, inadequate plumbing and wiring, and inefficient heating".

Approximately seven pages present signs of trouble or problems, and remedies for cracks in the foundation wall, efflorescence, water seepage and drainage, and structural framework (the latter section dealing only with wood structure of the floor system supported by the foundation and not with structural problems within the foundation or basement). The author cautions that "A crack that appears suddenly, however, or starts getting larger, may be a sign of more serious trouble and should be inspected by a structural engineer or foundation contractor".

Critique (continued)

This booklet is an excellent reference for the homeowner wanting to repair and maintain older homes in good condition. On foundation repairs, it provides short illustrated instructions for jobs simple enough for the non-specialist handyman and directs the homeowner to professional help when the problem is too complex for the do-it-yourselfer.

Title	Basement Water Leakage ... Causes, Prevention, And Correction
Author(s)	NAHB Research Foundation, Inc.
Publisher/Date/Pages	National Association of Home Builders of the United States, Washington, D.C./1978/30 pages
Available from/Price	
Catalogue & Indexing Numbers	CISTI 69.021.16
Key Words	
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

Described is a study undertaken to determine the best measures for preventing and correcting water leakage through cracks or joints in masonry block and cast-in-place concrete basement walls. A library search was conducted, technical experts of U.S. Federal agencies were consulted, a questionnaire was sent to builders (75% of the replies came from builders in midwestern and middle eastern states where basement construction is common), field trials of a coarse gravel fill under a floor slab drained by a sump and pump discharging to a storm sewer, and of adhering plastic film to masonry block walls with cold applied asphalt foundation coatings are reported. Further research is recommended and a preliminary discussion of basement construction to prevent leakage is presented.

Critique

Results of this survey of U.S. builder's problems with wet basements and construction details used to prevent leakage in masonry block and cast-in-place concrete basement walls are interesting but provide little in the way of new or proven solutions. The concept of adhering polyethylene film with cold-applied asphalt foundation coatings is introduced but substantiating proof of successful field performance is not provided in this report. This report might be referenced in introductory or historical sections of a comprehensive foundation repair manual.

Title	Residential Concrete
Author(s)	NAHB Research Foundation, Inc.
Publisher/Date/Pages	National Association of Home Builders of the United States, Washington, D.C./1983/71 pages
Available from/Price	
Catalogue & Indexing Numbers	NAHB ISBN 0-86718-158-3 Library of Congress Catalogue Card Number 83-60008
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Residential Concrete covers a wide range of topics to guide the house builder on how to insure good quality concrete. While not a training manual, it provides enough information on technique to allow the builder to recognize most faulty practices. Part 3 is devoted to concrete problems and remedies. Problems of scaling, spalling, plastic-shrinkage cracks, form tie holes, honeycomb, blisters and popouts are covered. Patching techniques with latex, epoxy, and dry-mix concrete are given.

Critique

This and the referenced publication "Concrete Repair Materials and Methods, Concrete Construction Publications, Inc., Addison, Illinois, July 1982, would be useful as source material for a foundation repair manual.

Title	Basement Waterproofers - Your Best Buys To Protect Your Rec Room
Author(s)	New Shelter's Product Testing and Evaluation Workshop
Publisher/Date/Pages	Rodale's New Shelter/April 1981/pages 39-48
Available from/Price	Rodale Press Inc., 33E. Minor St. Emmaus, PA, USA, 18049
Catalogue & Indexing Numbers	ISSN 0195-6582
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

Critique

New Shelter evaluated 22 "waterproofers" sold in U.S. hardware, building supply and paint stores and commonly used by home owners and handymen to treat water leakage through masonry walls on the inside. The Product Testing and Evaluation Workshop devised and used three tests to evaluate these products. Test One consisted of painting two coats of each waterproofer on specially constructed cinder blocks which was allowed to dry at least five days, then filling each cavity with dyed water. In Test Two, the maximum water pressure expected at the bottom of a basement wall (4 psi) was then applied to the blocks and the amount of water lost by the block in 24 hours was measured. In Test Three aluminum and steel strips were coated with the waterproofer. After drying the strips were bent over a one-inch round mandrel as a test of flexibility and adhesion. The two-part epoxies and the solvent based paints rated above average and are recommended "for the most severe water leakage problems". The reader is warned that "even the best of these products may fail to stop water leaks under very adverse conditions".

continued...

Critique continued...

The article has a list of product names, addresses and phone numbers for 19 suppliers of these products.

The article would be a source of information for sections of a foundation repair manual covering proprietary sealers and coatings.

Title	How To Waterproof Your Basement
Author(s)	Popular Mechanics do-it-yourself encyclopedia, Volume 2
Publisher/Date/Pages	The Hearst Corporation/1978/pages 280-283
Available from/Price	
Catalogue & Indexing Numbers	
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract	"If your problem is dampness or wetness, here are some solutions that you can try yourself - from simple cures for condensation to a thorough job of foundation waterproofing from the outside".
Critique	As might be expected from the date of publication, some aspects of this article are somewhat dated. It provides information for the reader which has been covered in several other publications in this review. The illustrations could be of use in preparing a foundation repair manual if permission was obtained from the publisher.

Title	Repairing Damp or Leaky Basements in Homes
Author(s)	Portland Cement Association, Skokie, Illinois
Publisher/Date/Pages	Portland Cement Association, Skokie, Illinois/undated/2 pages
Available from/Price	Canadian Portland Cement Association
Catalogue & Indexing Numbers	IS 129.03T
Key Words	
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

The causes and remedies for dampness and leakage in basements are discussed. A simple test for differentiating dampness due to condensation from that due to seepage or leakage is presented. Improving exterior surface and subsurface drainage to insure water is carried away from the foundation wall and repairing cracks or porous regions in masonry and concrete on the outside is the most effective way to correct major leakage problems. When seepage is minor and only occurs for short periods, inside crackfilling and inside surface coating may give satisfactory results.

Critique

This appears to be the best, two-page article on this subject presented by a North American cement industry association. It does not completely fill the need for a publication giving direction to contractors and owners considering repairs to basements prior to retrofitting insulation for energy conservation. It appears to downplay the difficulties of making repairs on the outside although stating this is the approach for most effective and lasting repairs. Similarly, more direction on repairing walls on the inside would also be helpful. This pamphlet would be used as source material in the preparation of any foundation repair manual.

Title	Concrete Problems
Author(s)	John C. Ropke
Publisher/Date/Pages	McGraw-Hill Book Company/1982/185 pages
Available from/Price	McGraw-Hill Book Company/$37.95
Catalogue & Indexing Numbers	ISBN 0-07-053609-0 TA 439.R73 666'.893 80-28433 AACRI
Key Words	
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

Critique

This book, written primarily for professionals and specialists contains a chapter entitled Concrete Repairs and another section entitled Cracks: Types. Although some reference might be made to this material in a comprehensive report on basement repairs prior to retrofitting, the above-noted Chapter would not be considered to fill the need for a repair manual. Little or no direct use would be made of this reference in preparation of a diagnostic sheet for basement retrofit contractors.

Title	How To Keep Your Basement Dry
Author(s)	Saskatchewan Government Insurance
Publisher/Date/Pages	Saskatchewan Government Insurance Regina, Saskatchewan/undated/12 page pamphlet
Available from/Price	
Catalogue & Indexing Numbers	
Key Words	
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This booklet shows some ways that a house holder can keep his basement dry during periods of potential flooding due to heavy summer rain storms. While some measures require the services of a plumber, there are other simple and inexpensive steps that can be taken in assessing and correcting potential problems.

Critique

Although this is written primarily to inform home owners of potential hazards and remedial measures to prevent or control flood damage to residential basements, several sections such as those dealing with cracks and seepage through basement walls, basement backwater valve, finishing your basement and cleaning up after the floor are well written and could be useful to a wider audience through the proposed foundation repair manual.

Title	Insulation Retrofit of Masonry Basements
Author(s)	J. Timusk, Department of Civil Engineering University of Toronto
Publisher/Date/Pages	Ontario Ministry of Municipal Affairs and Housing/1981/ 125 pages + 5 appendices
Available from/Price	Publication Services Section, Ministry of Government Services 5th Floor, 880 Bay Street, Toronto, Ontario M7A 1N8/$10.00
Catalogue & Indexing Numbers	ISBN 0-7743-7052-1
Key Words	Basement insulation/thermal retrofitting/survey existing masonry basements/crawl spaces/Toronto/retrofit options/costs/savings
Sector Applicability	Office Residential Restaurant Industrial Retail

Abstract

This lengthy report provides much theoretical and practical information necessary for understanding of heat and moisture flow through basement walls, floors and surrounding soil. The advantages and disadvantages of installing insulation on the interior or the exterior of masonry basements and crawl spaces are discussed. Basement wall and floor constructions in Toronto and other Ontario communities are described as typically of stone, rubble, clay brick, concrete block, and cast-in-place concrete. A survey in four Toronto neighborhoods of 160 cellars and basements ranging in age from 50 to more than 100 years, led to the conclusion that water tightness must be attained before any insulation is applied to masonry walls. Wherever feasible, external insulation is recommended over internal application. Guidance is given on preparation of wall surfaces, dampproofing, air tightening, cavity and crack filling, surface levelling and filling to insure insulation contact and cautions are given against internally insulating joist spaces, untreated wood against masonry below grade, air leakage paths circumventing insulation and thermal bridging problems. Selection of appropriate materials and construction details from the options available for retrofitting is discussed. Two

cont...

Abstract continued... methods of calculating basement heat losses are compared and judged equivalent. Heat losses from a typical uninsulated basement are analyzed, energy savings and costs for various retrofit options and two climatic conditions are calculated and compared. Weather data (average annual degree days below 18°C for Ontario) for 219 communities and a step-by-step procedure for analyzing costs and savings for basement thermal retrofitting are presented. Description is given of a demonstration of six surface protective coating materials and a flashing and fastening system for external insulation. Included are observations of performance after one year. Presumably observations and evaluations of performance have been continued after publication of this report.

Critique This is the authoritative reference to date on conditions found, and recommendations made, for upgrading masonry basements built in the last 100 years in Toronto (and other similar Ontario communities). It presents theoretical and practical information of value to both professional and layman. In many ways the report emphasizes the individuality of existing basements and crawl spaces and the need for intelligent assessment of existing conditions and prediction of any new conditions to be created, and the careful selection of the most appropriate materials and procedures to achieve good technical and economic performance. This would be an important source of reference material on preparing older masonry basements in preparation for thermal upgrading.

Title	Leaking Basements - Prevention Is Better Than Cure!
Author(s)	Stanley White
Publisher/Date/Pages	Concrete,Vol. 8, No. 8/August 1974/pages 28 & 29
Available from/Price	CISTI
Catalogue & Indexing Numbers	UC: 699.82; 69.021
Key Words	
Sector Applicability	Office Residential Restaurants Industrial Retail

Abstract

British standards, design and construction practices for watertight basements are discussed. Examples of poor design and poor construction are given. Designers and builders are reminded that in certain ground conditions perimeter drainage systems may draw down a watertable which in the past has been "contributing to the support of adjoining buildings". This has caused local settlements to occur. Drainage systems and waterproofing may not be completely successful in keeping water out of basements. Internal drainage systems may be an alternate remedy to handle small quantities of water which actually enter the building.

Critique

In some high groundwater conditions, it may be necessary to build structural, waterproofed basements which do not rely on groundwater draw down by perimeter drainage systems. Selection of insulation materials and details for energy conservation and to provide for location, drainage and repair of leaks will require unusual design, construction and repair practices. This article will be helpful in preparing sections on this subject in a foundation repair manual.

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THE GUIDE

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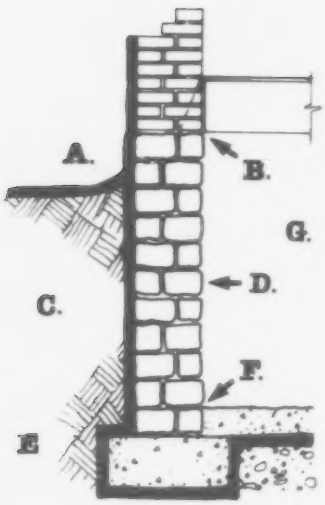
1. HOW TO USE THIS GUIDE

1.1 Explanation of the categories



The main part of the Guide is broken down into seven categories, which are based on individual areas of examination:

A. Exterior examination of walls near and above grade.
B. Interior examination of walls near and above grade.
C. Exterior examination of walls below grade.
D. Interior examination of walls below grade.
E. Exterior examination of wall footings.
F. Interior examination of wall footings and floor.
G. Examination for conditions concealed behind wall finish.

These points of inspection are shown in the accompanying figure.

1.2 Division according to symptoms

Within each of the above categories, a number of symptoms have been identified. A separate case number is assigned to each symptom, and this information is summarized on the first page of each category. Each symptom is then treated individually, with an explanation of the usual causes and a brief statement of the recommended remedial measures. Where necessary the recommended remedial measures are supported by detailed notes, and figures are included to show how to identify the symptom.

1.3 Assessing the severity of the symptoms

This is an important first step in the diagnostic procedure. When a particular symptom has been identified, the contractor and the homeowner should come to some agreement on the severity of the symptom. There are three possible conditions:

Condition 1. no evidence of the condition found;
Condition 2. minor or mild symptoms found or suspected;
Condition 3. major or severe symptoms found.

The remedial work should then follow the recommended actions for Condition 2 or Condition 3 - whichever has been agreed upon. If ratings by contractor and owner do not agree, a third party inspection is recommended.

1.4 Supplementary information from the homeowner

The diagnosis of problems and their causes is not always easy. Sometimes the original cause may have disappeared and will not be evident at the time of examination. It is therefore recommended that the contractor consult with the homeowner to gather any useful background information. A sheet has therefore been included under the heading of "Homeowner Questionnaire". This will give the contractor some guidance on the kinds of questions to ask.

1.5 General caution regarding new basements

In most jurisdictions the original building contractor is responsible for defects in his construction for a period of at least one year. This could cause legal problems for the owner and retrofitting contractor if defects of the original construction are

not identified and corrected before retrofitting is started.

The owner should have his original contractor carry out any retrofitting within the warranty period, or should obtain guarantees that the proposed retrofit will have no effect on the original warranty.

Second owners who are considering retrofit during the warranty period would be well advised to investigate the legal implications.

2. GLOSSARY OF UNFAMILIAR TERMS

Brush coating:

A thin parging mixture with or without sand. It is usually applied with a whitewash brush.

Wash coating:

Similar to a brush coating, but thinner - being the consistency of paint. It is usually applied with a whitewash brush or squeegee.

Trowel coat:

A relatively thick base coat of parging applied with a trowel.

Two-coat parging:

Parging applied in two coats. The first coat is a thick levelling coat, the surface of which is left rough for bonding of the second coat. The second coat is a finish coat.

Shotcrete resurfacing:

Parging which is spayed onto the wall under high pressure.

Reinforcing and bonding coatings:

A high-strength proprietory surface coating. These are fast-setting coatings, often incorporating fibre reinforcing.

3. HOMEOWNER QUESTIONNAIRE

PART 1: Basic Information

If the basement walls have been partially or completely finished on the inside please answer the following questions with as much detail as possible:

1. When was the finish installed?

   _____

2. By whom?

   _____

3. Can you supply complete details of the construction in cross-section from inside finished surface to the outside of the basement wall, both above-grade and below grade?
   (Give details on separate sheet, or attach sketches)

4. Have you or previous occupants ever experienced frozen pipes, water leakage or odours issuing from finished basement walls?

   _____

PART 2: Occasional Problems

Has this or any of the neighbouring houses ever experienced any of the following:

1. Sewer back up? _____

2. Flooding due to waterline breakage or other cause? _____

3. Floor drain does not completely drain water from the basement floor surface? _____

4. Floor drain occasionally or continually issues cold air into basement? _____

If the answer to any of these questions is yes, it is recommended that the basement not be finished to floor level until remedial measures are taken to minimize or eliminate future occurrences.

CATEGORY A

EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

Cases in this category:

Case 1. Mortar cracked or missing
Case 2. Random cracks in stucco or concrete
Case 3. Pattern cracks or popouts in concrete
Case 4. Staining or efflorescence
Case 5. Roof runoff ponding near foundation
Case 6. Surface water collecting near foundation
Case 7. Cracks in wall caused by attached or adjacent structures
Case 8. Vertical or inclined cracks not wider than 3 mm and not penetrating full thickness of wall
Case 9. Cracks or holes wider than 3 mm which penetrate full thickness of wall.
Case 10. Water ponding in window wells
Case 11. Cracks between foundation wall and backfill

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 1

SYMPTOMS

Mortar cracked or missing, masonry units deteriorating.

USUAL CAUSES

Wetting/drying or freezing/thawing cycles.

RECOMMENDED ACTIONS

Condition 2:

Re-point mortar; exterior retrofit advisable (See Note).

Condition 3:

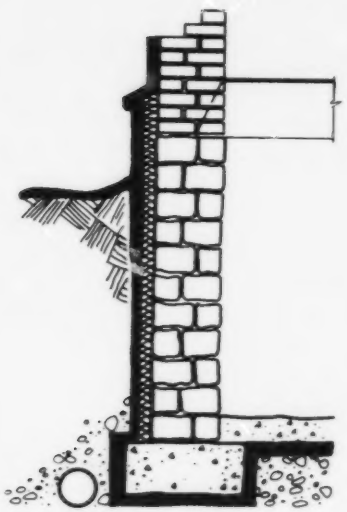
If masonry deterioration is severe a specialist masonry contractor may be required to restore structural integrity (See Note).

NOTES

Crumbling masonry or concrete due to frost action, frequent wetting and drying, and/or large changes in temperature may be aggravated by insulating on the inside. If combined with wood rot or other problems of structural significance, complete structural repair by a specialist foundation contractor must be carried out before any retrofitting is started. Retrofitting on the outside is probably the best option after the repairs have been completed.

Dampness, leakage of water and occasional flooding are problems commonly associated with rubble and stone wall construction. If the basement is to be upgraded, excavation to the footing level and parging and dampproofing of the exterior wall face is essential. Surface water must be diverted and foundation drainage ensured in some manner. While such an upgrading task may be unrelated to thermal upgrading, it provides a good opportunity for the installation of exterior insulation.

The application of interior insulation to a rubble



wall lacking proper dampproofing or exterior drainage is not advisable, particularly at the wall/joist intersection. The reduction of heat loss to the moisture-saturated walls may cause freeze/thaw damage. If joist spaces are insulated, moisture drawn up through the wall will condense in the joist area and may cause eventual deterioration of the wood.

A two-coat parging applied to a thoroughly cleaned outside surface will provide a good base on which to apply liquid or membrane dampproofing and drainable or impermeable insulation and a new exterior foundation drainage tile system as shown in Figure 1. The final coat of parging must be as smooth and as flat as possible so that the insulation will fit tightly against the wall. Near and above grade, the insulation must be covered with a protective coating, such as cement parging on wire mesh reinforcement, and capped at the top to shed water and prevent infiltration.

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 2

SYMPTOMS

Random cracks in stucco or concrete.

USUAL CAUSES

Shrinkage of material.

RECOMMENDED ACTIONS

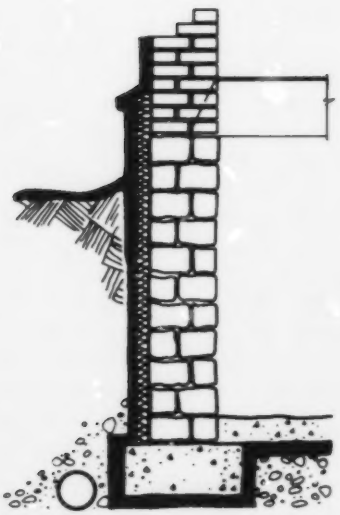
Condition 2:

Apply a wash coat.

Condition 3:

Apply a brush coat of cement-based paint or a new parging coat (See Note).

NOTES



Random, hairline cracks in stucco, mortar or concrete, may or may not need repair depending to some extent on the subsequent exposure of the affected surface. An exterior parging or stucco coat may be the main air barrier covering the foundation-superstructure connections. If retrofitting is to include exterior insulation carried below grade and above the main floor level, as illustrated in Figure 1, a liquid or membrane air-vapour barrier should be applied on the exterior surface of the parging or stucco prior to the installation of exterior insulation, framing and protective covering. If the existing stucco or parging is expected to continue as the external surface, with or without internal retrofitting, cracks should be closed and covered with cement-based paints or wash coatings to improve airtightness, to retard deterioration processes and to restore good surface condition and appearance. Superficial cracks in concrete or masonry structures may not transmit air or moisture through the structure but may become more active under adverse exposure conditions and should be closed or covered with paints or coatings to slow the deterioration processes and restore good surface conditions and appearance.

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 3

SYMPTOMS

Pattern cracks or popouts in concrete.

USUAL CAUSES

Expansion of aggregates may occur as a result of moisture or chemical attack.

RECOMMENDED ACTIONS

Condition 2:

Install exterior insulation.

Condition 3:

Consult concrete specialist first (See Note).

NOTES

Certain types of gravel or crushed stone aggregates used in the manufacture of concrete react undesirably when exposed to the moisture and/or chemical environment of the concrete mass. Certain siliceous mineral constituents of aggregates may react with the alkalies in portland cement, causing disruptive expansion and severe cracking of concrete. If concrete contains particles of clay, shale, hardburned lime or magnesia, which expand when exposed to water, these may exert sufficient force to break out cone-shaped pieces of concrete called popouts. Although relatively rare as a result of modern quality control of materials used in concrete manufacture, severe deterioration has occurred in certain localities and the advice of local experts should be sought when symptoms are found. If severe deterioration has been observed, the services of an experienced structural/foundation engineer may be required to design and direct restoration before sealing and insulating. Any measures which lead to reducing the supply of water and keeping the concrete dry will generally be beneficial. External retrofits of insulation, which include improvements in waterproofing and drainage, will produce more favourable

exposure conditions which should reduce the rate of deterioration.

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 4

SYMPTOMS

Staining or efflorescence. Efflorescence is a whitish, crystalline powder left after the evaporation of water containing dissolved salts.

USUAL CAUSES

Moisture from exterior or interior sources.

RECOMMENDED ACTIONS

Condition 2:

Find and eliminate source of moisture.

Condition 3:

Consult masonry or concrete specialist (See Note).

NOTES

There are numerous causes of stains on concrete and masonry surfaces. On poured concrete walls these are: form-release agents, mill scale on steel forms (from the steel manufacturing process) and phenolic resin glues in plywood forms sometimes cause surface discolouration which are of little or no structural consequence. Rust stains may develop when reinforcing steel or form tie rods are not sufficiently covered with dense concrete. Heavy staining usually indicates considerable water movement which must be corrected before any interior insulation and finishing is carried out. Leaking form tie holes can sometimes be plugged from the inside but unless the external source of moisture is corrected, the permanency of inside repairs may be in doubt.

White powdery or crystalline deposits in cracks or on the surface of concrete or masonry are called efflorescence and usually indicate that water has

moved through, or out of, concrete or masonry and evaporated at that location. The salts deposited may be carbonates, chlorides, free lime or sulphates. Carbonates and free lime are usually derived from the concrete or masonry constituents. Chlorides may originate in the concrete mix or from de-icing salts used on nearby pavements. Deposits of carbonates or free lime are primarily of interest as indicators of moisture flow to that point of evaporation. Efflorescence on the outside of basement walls above grade is unsightly and may indicate wetting problems originating higher in the structure, excessive surface wetting due to lawn or garden watering or driving rain, or wicking of ground moisture. Efflorescence on the inside of basement walls below grade usually indicates inadequate drainage of the backfill or excessive wetness at the footing level. Heavy efflorescence of sulphates should raise concern about progressive breakdown of concrete or masonry unless the supply of sulphate bearing water is stopped.

Interior retrofitting would not be recommended on walls showing staining or efflorescence, until the sources of moisture and the extent of damage to the structure have been identified by a qualified specialist and permanently corrected. The upward movement of sulphate-bearing groundwater through footings and the base of foundation walls or columns may be particularly difficult to stop.

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 5

SYMPTOMS

Water from roof runoff ponding and soaking backfill against foundation.

USUAL CAUSES

Inadequate roof drainage system.

RECOMMENDED ACTIONS

Condition 2:

Upgrade eavestroughing and downspouts, and carry drainage well away from house.

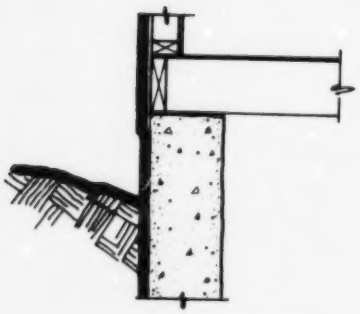
Condition 3:

Same as Condition 2.

NOTES

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 6



SYMPTOMS

Surface water collecting and soaking backfill against foundation.

USUAL CAUSES

Ground surface slopes towards rather than away from basement wall.

RECOMMENDED ACTIONS

Condition 2:

Re-grade ground surface to slope away from house.

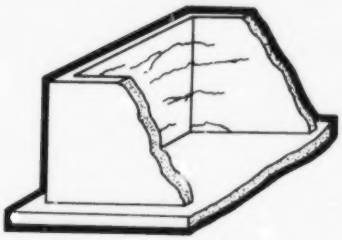
Condition 3:

Install a special drainage system to carry water to a storm drain. This may require the services of a drainage contractor.

NOTES

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 7



Horizontal Cracks

SYMPTOMS

Horizontal cracks in masonry or concrete wider than 3 mm; or bending of the wall; or displacements at, above or near grade in proximity to attached or adjoining structures such as pavements, door steps, planters and foundations of attached garages.

USUAL CAUSES

Wall structure not strong enough to withstand extra stresses and strains imposed by adjoining structure, or stresses caused by clay soil swelling or expansion of soil due to frost action

RECOMMENDED ACTIONS

Condition 2:

Further damage may be averted by disconnecting adjoining structures from the basement and/or insulating sub-grades (See Note).

Condition 3:

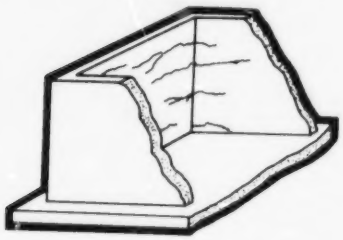
Severe cracking, bowing or displacements of the wall structure require the analysis and design attentions of an experienced structural/foundation engineer.

NOTES

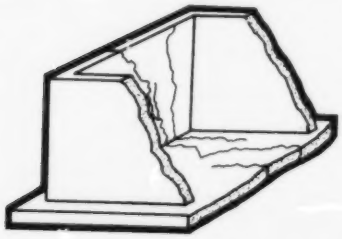
Where there are adjoining unheated structures such as pavements, sidewalks, and garage floors, it is useful to insulate below grade to gain advantages in energy conservation and reduced maintenance due to seasonal ground movements. The design and the supervision of construction of these insulation systems require the services of an experienced geotechnical/foundation engineer.

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 8



Horizontal Cracks



Vertical Cracks

SYMPTOMS

Vertical, horizontal or inclined cracks in concrete or masonry not wider than 3 mm and not penetrating the full thickness of the wall.

USUAL CAUSES

Drying shrinkage, repeated wetting/drying, freezing/thawing cycles or thermal expansion and contraction cycles can lead to this problem.

RECOMMENDED ACTIONS

Condition 2:

New parging coat or brush coat with cement-based paint or grout will improve appearance and longevity (See Note).

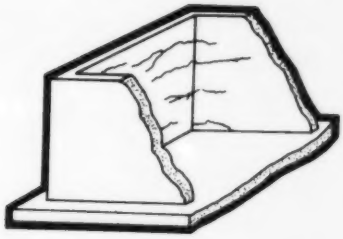
Condition 3:

NOTES

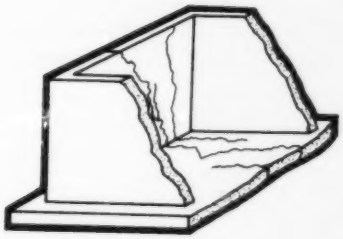
Dry, dormant cracks, which do not penetrate the full thickness of concrete or masonry and do not exceed 3 mm in width, may be repaired with a wide range of proprietary patchers or sealers, or with brush or trowel coatings of cement plaster. Latex caulks and one-part urethanes have been used successfully above-grade, as have epoxy gels below-grade, when applied in accordance with manufacturers' instructions.

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 9



Horizontal Cracks



Vertical Cracks

SYMPTOMS

Vertical, horizontal or inclined cracks or holes wider than 3 mm which penetrate the full thickness of the wall, with or without displacement of the wall, and extending below grade.

USUAL CAUSES

No control joints provided for drying shrinkage or thermal expansion or contraction - and/or wall insufficiently strong for the height or type of backfill used, or nearby loading of the ground surface.

RECOMMENDED ACTIONS

Condition 2:

Exterior repairs and retrofitting may stabilize thermal conditions (See Note 1).

Condition 3:

Severe cracking, bowing and/or displacements require the analysis and design attentions of an experienced structural/foundation engineer (See Note 2).

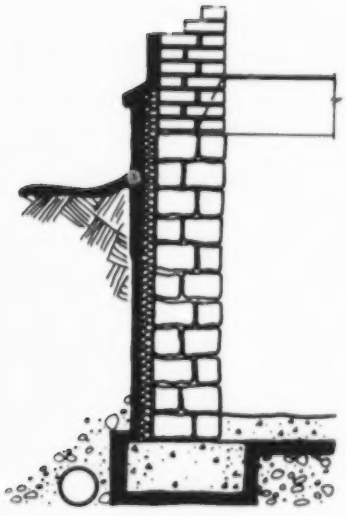
NOTES

Note 1.

Crumbling masonry or concrete due to frost action, frequent wetting and drying, and/or large changes in temperature may be aggravated by insulating on the inside. If combined with wood rot or other problems of structural significance, complete structural repair by a specialist foundation contractor must be carried out before any retrofitting is started. Retrofitting on the outside is probably the best option after the repairs have been completed.

Dampness, leakage of water and occasional flooding are problems commonly associated with rubble and stone wall construction. If the basement is to be upgraded, excavation to the footing level and parging and dampproofing of the exterior wall face is essential. Surface water must be diverted and foundation drainage ensured in some manner. While such an upgrading task may be unrelated to thermal upgrading, it provides a good opportunity for the installation of exterior insulation.

The application of interior insulation to a rubble wall lacking proper dampproofing or exterior drainage is not advisable, particularly at the wall/joist intersection. The reduction of heat loss to the moisture-saturated walls may cause freeze/thaw damage. If joist spaces are insulated, moisture drawn up through the wall will condense in the joist area and may cause eventual deterioration of the wood.



A two-coat parging applied to a thoroughly cleaned outside surface will provide a good base on which to apply liquid or membrane dampproofing and drainable or impermeable insulation and a new exterior foundation drainage tile system as shown in Figure 1. The final coat of parging must be as smooth and as flat as possible so that the insulation will fit tightly against the wall. Near and above grade, the insulation must be covered with a protective coating, such as cement parging on wire mesh reinforcement, and capped at the top to shed water and prevent infiltration.

Note 2:

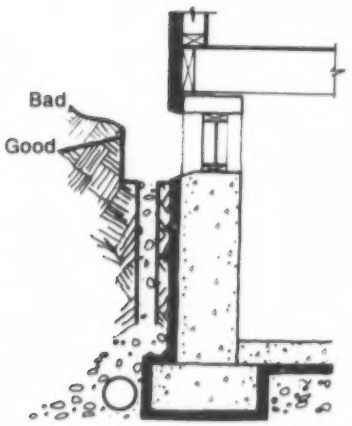
Severely cracked and/or displaced foundation walls should be examined by an experienced structural-foundation engineer. The engineer's report should include a rehabilitation design for structural safety and recommendations for drainage and thermal upgrading. Once the structural sufficiency and adequacy of drainage have been assured, crack filling and moisture proofing can be carried out. Cracks which penetrate the full thickness of a foun-

dation wall are best repaired from the outside if a trench can be dug wide and deep enough for access. The wall surface near the crack should be thoroughly cleaned by brushing and washing to remove all dirt and loose material. If the construction is of unit masonry, any loose mortar should be removed to a depth of 18-20 mm, then moistened before repointing with a stiff cement-sand mortar consisting of 1 part of portland cement to 1 1/2 parts of mortar sand by volume. An acrylic latex bonding agent can significantly improve the mortar. Cracks in concrete or masonry units can be repaired by routing out to a depth of at least 12 mm and a width of at least 18 mm. All loose material and dust must be removed. Various crack fillers or sealants including polysulfide, polyurethane, epoxy, silicone, modified polymer cement or latex modified cement mortars have been used successfully to repair cracks from the outside. The choice of crack repair materials must take into account the compatibility with the materials to be overlaid. For walls with generally poor surface conditions a two-coat parging or a shotcrete resurfacing may be necessary. Special reinforcing and bonding coatings may be used to seal and strengthen walls.

If for economic or other reasons, crack repairs must be made from the inside, the services of a contractor specializing in concrete repair is recommended.

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 10



SYMPTOMS

Water ponds in window wells.

USUAL CAUSES

Window wells inadequately drained due to lack of connection to a functioning foundation drainage system.

RECOMMENDED ACTIONS

Condition 2:

Direct surface water away from window well by improving surface grading.

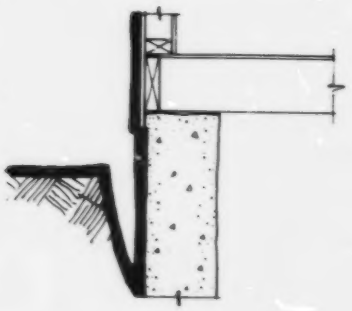
Condition 3:

Carefully auger hole vertically from window well towards footing-drain depth. If satisfied good drainage is possible, fill auger hole with graded filter gravel to ensure continuous drainage and no silting of the foundation tiles.

NOTES

CATEGORY A: EXTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 11



SYMPTOMS

Open cracks in soil between foundation wall and backfill.

USUAL CAUSES

Shrinkage of backfill soil.

RECOMMENDED ACTIONS

Condition 2:

Condition 3:

Advice of local geotechnical/foundation engineer should be obtained before attempting to seal or fill these cracks. If the crack is filled with soil that has a high swelling potential, subsequent expansion of the soil may cause further cracking. Removal and replacement of backfill with material having little or no clay content may be advisable if original backfill is of moderate to high swelling potential.

NOTES

CATEGORY B

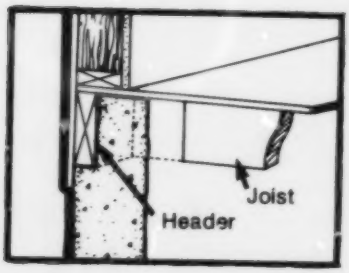
INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

Cases in this category:

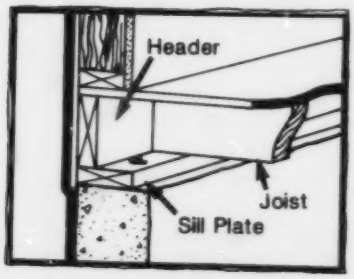
Case 1. Decayed wood, mould or fungus growth
Case 2. Cracked, warped or excessively shrunk lumber
Case 3. Dampening, darkenening or efflorescence on concrete or masonry
Case 4. Weak, crumbling concrete or masonry
Case 5. Porous concrete or masonry
Case 6. Horizontal cracks or displacements in masonry or concrete
Case 7. Vertical or inclined cracks not wider than 3 mm
Case 8. Cracks or holes wider than 3 mm
Case 9. Air leakage, excessive infiltration
Case 10. Open cracks leaking air or water
Case 11. Damp walls above grade
Case 12. Damp walls near or below grade

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 1



Beam-In-Fill Method



Box Sill Method

SYMPTOMS

Soft decayed wood, mould or fungus growth on the joists, sill plate, etc.

USUAL CAUSES

Moisture accumulating due to condensation, leakage or wicking through porous materials.

RECOMMENDED ACTIONS

Condition 2:

Find and eliminate the source of moisture (See Note). If mould or decay are only superficial, remedy by cleaning and sterilizing all affected surfaces. Only exterior insulation is recommended to avoid future occurrences.

Condition 3:

Severe wood rotting can present serious structural hazards. Consult structural/foundation engineer for rehabilitation design. Only exterior insulation is recommended.

NOTES

Several simple tests have been devised to determine whether surface wetness is due to condensation, seepage or wicking of moisture. Condensation of atmospheric moisture occurs on surfaces at or below the dew point temperature of the air. If a small mirror or a shiny sheet of metal taped in close contact with the wall becomes covered with mist or water droplets after a few hours of exposure, it is probably correct to conclude that condensation of atmospheric moisture is contributing to the wetting. Another variation of the test is to tape a small square of transparent polyethylene film or other vapour barrier to the wall surface after the surface has been dried off with a hair dryer or heater fan. If, after several hours of exposure, moisture is found on the wall side of the film, the conclusions would be that moisture has moved out of the wall in

liquid or vapour form. If mist or water droplets collect only on the room side of the film it would be concluded that condensation of atmospheric moisture is the source. If moisture is found on both sides, it is probable that wetting is caused by both condensation and seepage from the wall.

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 2

SYMPTOMS

Cracked, warped, poorly seated or excessively shrunk lumber.

USUAL CAUSES

Drying of lumber in heated, ventilated exposure.

RECOMMENDED ACTIONS

Condition 2:

Cracks may require extensive caulking for airtightness.

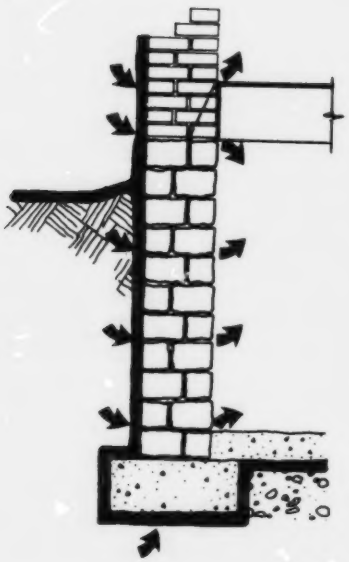
Condition 3:

Severe cracking and warping may affect structural safety. Consult a structural engineer.

NOTES

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 3



SYMPTOMS

Damp or darkened concrete or masonry; or accumulation of whitish powder or crystals.

USUAL CAUSES

Free moisture in concrete with or without mildewing gives dark appearance. Whitish crystalline or powdery deposits left after water-bearing dissolved salts evaporate is efflorescence.

RECOMMENDED ACTIONS

Condition 2:

Find and eliminate sources of moisture before retrofitting (See Note 1).

Condition 3:

In severe cases only improved exterior drainage, waterproofing and insulation is recommended (See Notes 2 and 3).

NOTES

Note 1:

Several simple tests have been devised to determine whether surface wetness is due to condensation, seepage or wicking of moisture. Condensation of atmospheric moisture occurs on surfaces at or below the dew point temperature of the air. If a small mirror or a shiny sheet of metal taped in close contact with the wall becomes covered with mist or water droplets after a few hours of exposure, it is probably correct to conclude that condensation of atmospheric moisture is contributing to the wetting. Another variation of the test is to tape a small square of transparent polyethylene film or other vapour barrier to the wall surface after the surface

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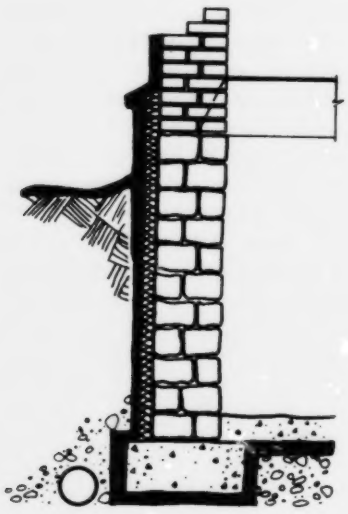
Note 2:

Crumbling masonry or concrete due to frost action, frequent wetting and drying, and/or large changes in temperature may be aggravated by insulating on the inside. If combined with wood rot or other problems of structural significance, complete structural repair by a specialist foundation contractor must be carried out before any retrofitting is started. Retrofitting on the outside is probably the best option after the repairs have been completed.

Dampness, leakage of water and occasional flooding are problems commonly associated with rubble and stone wall construction. If the basement is to be upgraded, excavation to the footing level and parging and dampproofing of the exterior wall face is essential. Surface water must be diverted and foundation drainage ensured in some manner. While such an upgrading task may be unrelated to thermal upgrading, it provides a good opportunity for the installation of exterior insulation.

The application of interior insulation to a rubble wall lacking proper dampproofing or exterior drainage is not advisable, particularly at the wall/joist intersection. The reduction of heat loss to the moisture-saturated walls may cause freeze/thaw damage. If joist spaces are insulated, moisture drawn up through the wall will condense in the joist area and may cause eventual deterioration of the wood.



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Note 3:

There are numerous causes of stains on concrete and masonry surfaces. On poured concrete walls these are: form-release agents, mill scale on steel forms and phenolic resin glues in plywood forms sometimes cause surface discolouration which are of little or no structural consequence. Rust stains may develop when reinforcing steel or form tie rods are not sufficiently covered with dense concrete. Heavy staining usually indicates considerable water movement which must be corrected before any interior insulation and finishing is carried out. Leaking form tie holes can sometimes be plugged from the inside but unless the external source of moisture is corrected, the permanency of inside repairs may be in doubt.

White powdery or crystalline deposits in cracks or on the surface of concrete or masonry are called efflorescence and usually indicate that water has moved through, or out of, concrete or masonry and evaporated at that location. The salts deposited may be carbonates, chlorides, free lime or sulphates. Carbonates and free lime are usually derived from the concrete or masonry constituents. Chlorides may originate in the concrete mix or from de-icing salts used on nearby pavements. Deposits of carbonates or free lime are primarily of interest as indicators of moisture flow to that point of evaporation. Efflorescence on the outside of basement walls above grade is unsightly and may indicate wetting problems originating higher in the structure, excessive surface wetting due to irrigation or driving rain, or wicking of ground moisture. Efflorescence on the inside of basement walls below grade

usually indicates inadequate drainage of the backfill or excessive wetness at the footing level. Heavy efflorescence of sulphates should raise concern about progressive breakdown of concrete or masonry unless the supply of sulphate bearing water is stopped. Interior retrofitting would not be recommended on walls showing staining or efflorescence, until the sources of moisture and the extent of damage to the structure have been identified by a qualified specialist and permanently corrected. The upward movement of sulphate-bearing groundwater through footings and the base of foundation walls or columns may be particularly difficult to stop.

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 4

SYMPTOMS

Weak or crumbling concrete or masonry.

USUAL CAUSES

Frost action, wetting and drying, large temperature changes, poor quality construction.

RECOMMENDED ACTIONS

Condition 2:

See Note.

Condition 3:

See Note.

NOTES

Masonry or concrete weakened by frost action, wetting and drying, or large changes in temperature or chemical attack may experience accelerated breakdown after insulation is retrofitted on the inside. Severe cases should be examined by, and restoration plans prepared by, an experienced structural engineer. Structural repairs and moisture proofing must be completed by a specialist contractor before any retrofitting is started. Retrofitting on the outside will usually be the best course for long term performance.

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 5

SYMPTOMS

Porous concrete or masonry surfaces.

USUAL CAUSES

Poor construction materials or practices, or deterioration due to physical and chemical attack.

RECOMMENDED ACTIONS

Condition 2:

See Note.

Condition 3:

See Note.

NOTES

Improper placement of concrete is frequently the cause of honeycombing, porous zones and cold joints in basement walls.

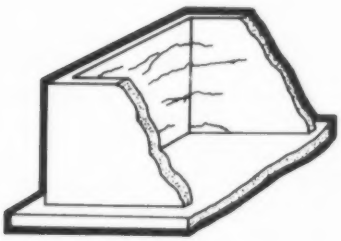
The formation of irregular holes and exposed coarse aggregates during placing of concrete in forms is often called honeycombing. Failure of the mortar fraction to fill the spaces between coarse aggregate particles may result when forms are not tight enough to prevent loss of cement mortar. Improper placement of concrete into the forms, and improper or insufficient vibration may also be contributory causes.

Excessive delay in placing subsequent lifts of concrete into the forms or insufficient vibration through to underlying lifts are usual causes of 'cold joints'.

Superficial honeycombs and cold joints that have not leaked air or water through several seasons of exposure may be patched with acrylic latex modified cement mortar, epoxy gels or other commercial patching compounds, after all loose material has been removed and the cavity has been enlarged until sound concrete is reached. Undercutting the cavity will help to key the patch to the original concrete. All dust and loose particles must be removed and other preparations required by the manufacturer's directions must be strictly carried out before the patching material is applied. Cement-based mortars should be kept from drying out too rapidly. Light water spraying during the curing period, or a sprayed-on curing compound, may be required to assist curing. Deep honeycombs and cold joints with serious leakage potential will require specialized repair methods and materials by specialty concrete repair contractors.

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 6



Horizontal Cracks

SYMPTOMS

Large horizontal cracks and displacements in masonry or concrete.

USUAL CAUSES

Usually excessive lateral loading due to backfill, adjoining structures or heavy load nearby (eg. a vehicle).

RECOMMENDED ACTIONS

Condition 2:

Further damage may be averted by disconnecting adjoining structures.

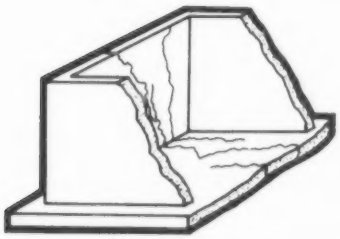
Condition 3:

Severe cracking, bowing or displacements of the wall structure require the analysis and design attentions of an experienced structural/foundation engineer.

NOTES

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 7



Vertical Cracks

SYMPTOMS

Vertical or inclined cracks in concrete or masonry not wider than 3 mm.

USUAL CAUSES

May indicate inward deflection of wall.

RECOMMENDED ACTIONS

Condition 2:

New parging coat or brush coat with cement-based paint or grout will improve appearance and longevity (See Note). If inward deflection is observed consult a structural engineer for assessment of structural hazards and rehabilitation design.

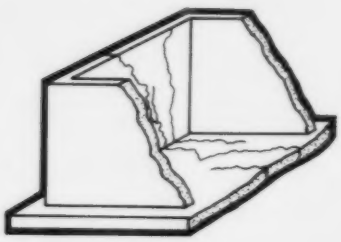
Condition 3:

NOTES

Dry, dormant cracks, which do not penetrate the full thickness of concrete or masonry and do not exceed 3 mm in width, may be repaired with a wide range of proprietary patchers or sealers, or with brush or trowel coatings of cement plaster. Latex caulks and one-part urethanes have been used successfully above-grade, as have epoxy gels below-grade, when applied in accordance with manufacturers' instructions.

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 8



Vertical Cracks

SYMPTOMS

Vertical or inclined cracks in concrete masonry wider than 3 mm.

USUAL CAUSES

May be shrinkage cracks in unreinforced concrete walls or masonry walls longer than 6 m which have not been provided with control joints for shrinkage and thermal expansion/contraction. Inclined cracks usually indicate vertical movement of the wall. Vertical cracks often indicate horizontal deflection or bowing.

RECOMMENDED ACTIONS

Condition 2:

Exterior repairs and retrofit may stabilize thermal conditions (See Notes).

Condition 3:

Severe cracking, bowing and/or displacements require the analysis and design attentions of an experienced structural/foundation engineer (See Notes).

NOTES

Severely cracked and/or displaced foundation walls should be examined by an experienced structural/-foundation engineer. The engineer's report should include a rehabilitation design for structural safety and recommendations for drainage and thermal upgrading. Once the structural sufficiency and adequacy of drainage have been assured, crack filling and moisture proofing can be carried out. Cracks which penetrate the full thickness of a foundation wall are best repaired from the outside if a trench can be dug wide and deep enough for access. The wall surface near the crack should be thoroughly cleaned by brushing and washing to remove all dirt and loose material. If the construction is of unit

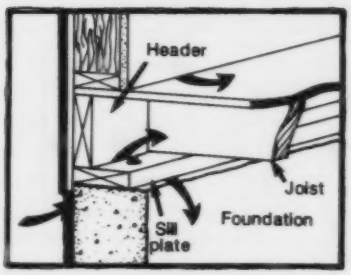
masonry, any loose mortar should be removed to a depth of 18-20 mm, then moistened before repointing with a stiff cement-sand mortar consisting of 1 part of portland cement to 1 1/2 parts of mortar sand by volume. An acrylic latex bonding agent can significantly improve the mortar. Cracks in concrete or masonry units can be repaired by routing out to a depth of at least 12 mm and a width of at least 18 mm. All loose material and dust must be removed. Various crack fillers or sealants including polysulfide, polyurethane, epoxy, silicone, modified polymer cement or latex modified cement mortars have been used successfully to repair cracks from the outside. The choice of crack repair materials must take into account the compatibility with the materials to be overlaid. For walls with generally poor surface conditions a two-coat parging or a shotcrete resurfacing may be necessary. Special reinforcing and bonding coatings may be used to seal and strengthen walls.

If for economic or other reasons, crack repairs must be made from the inside, the services of a contractor specializing in concrete repair is recommended.

Where expansive clays are used as backfills, horizontal bending and cracking of basement walls may occur suddenly anytime during the life of the structure, or progressively through several cycles of expansion and contraction of backfill soils. Wetting and drying, freezing and thawing and infilling of the cracks between the foundation and the ground may be contributing conditions. In areas such as the Red River Valley of Manitoba and the Regina Plains of Saskatchewan, particularly severe problems due to expansive clay subsoils and backfills are addressed to a certain extent by local building bylaws. Severely cracked or displaced foundation walls should be examined for structural safety, and rehabilitation work should be designed and supervised by an experienced structural/foundation engineer before any retrofitting is carried out.

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 9



SYMPTOMS

Air leakage, excessive infiltration at the foundation-superstructure connections.

USUAL CAUSES

Cracks at joints and in materials such as stucco, wood, concrete and masonry tend to open more with age and exposure.

RECOMMENDED ACTIONS

Condition 2:

Some reduction in air leakage can usually be achieved with interior sealing. See the BETT Manual 'Air Sealing Homes for Energy Conservation.'

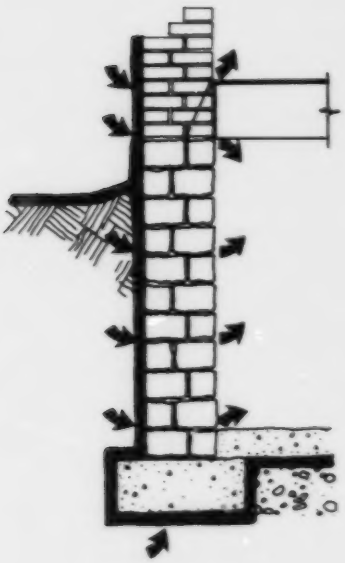
Condition 3:

If interior finish or other obstructions make it impossible to complete the air and vapour barriers from the inside an external retrofit or combination of external and internal retrofit may be necessary to reduce excessive infiltration.

NOTES

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 10



SYMPTOMS

Open cracks through concrete, mortar parging or masonry units - above or below grade - leaking air or water.

USUAL CAUSES

Hairline cracks randomly distributed throughout the concrete are usually shrinkage cracks. Cracks originating at window corners or other points of weakness in long reinforced concrete or masonry walls may be shrinkage cracks or structural cracks caused by excessive loads and movement of the wall.

RECOMMENDED ACTIONS

Condition 2:

Hairline cracks in mortar, parging or concrete may be repaired as described in Note 1. Shrinkage or thermal cracks may be repaired as described in Note 2.

Condition 3:

Specialist structural and geotechnical expertise may be required to predict future extent of damage and recommend remedial measures.

NOTES

Note 1:

Dry, dormant cracks, which do not penetrate the full thickness of concrete or masonry and do not exceed 3 mm in width, may be repaired with a wide range of proprietary patchers or sealers, or with brush or trowel coatings of cement plaster. Latex caulks and one-part urethanes have been used successfully above-grade, as have epoxy gels below-grade, when

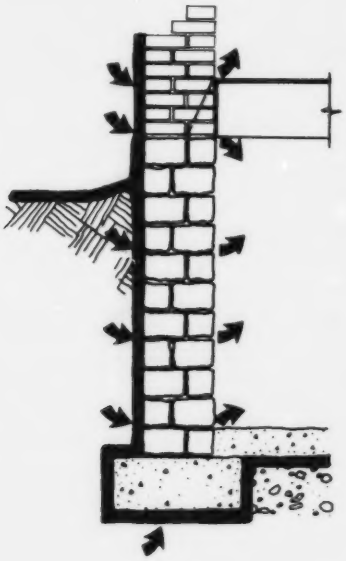
applied in accordance with manufacturers' instructions.

Note 2:

Cracks which have been observed to open and close to a greater or lesser extent with seasons or with temperature cycles should be repaired so as to continue to function as expansion and contraction joints. This can best be accomplished on the outside of the wall by routing out the crack to a depth of at least 12 mm and a width of 18 mm, then cleaning of all dust and particles and caulking with elastomeric joint sealant or other sealant compatible with materials to be overlaid. The above procedure may not be necessary if a waterproofing and/or vapour barrier membrane is to be installed on the exterior of the wall as part of an exterior insulation retrofitting.

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 11



SYMPTOMS

Damp walls above grade.

USUAL CAUSES

Condensation will occur on a basement wall whenever the surface temperature is below the dew point of the air that is in contact - a common cold season phenomenon.

RECOMMENDED ACTIONS

Condition 2:

Test for condensation or seepage as explained in Note.

Condition 3:

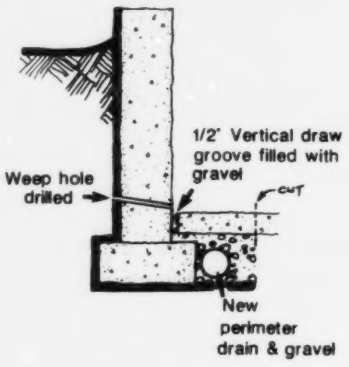
NOTES

Several simple tests have been devised to determine whether surface wetness is due to condensation, seepage or wicking of moisture. Condensation of atmospheric moisture occurs on surfaces at or below the dew point temperature of the air. If a small mirror or a shiny sheet of metal taped in close contact with the wall becomes covered with mist or water droplets after a few hours of exposure, it is probably correct to conclude that condensation of atmospheric moisture is contributing to the wetting. Another variation of the test is to tape a small square of transparent polyethylene film or other vapour barrier to the wall surface after the surface has been dried off with a hair dryer or heater fan. If, after several hours of exposure, moisture is found on the wall side of the film, the conclusions would be that moisture has moved out of the wall in liquid or vapour form. If mist or water droplets collect only on the room side of the film it would be concluded that condensation of atmospheric moisture is the source. If moisture is found on both

sides, it is probable that wetting is caused by both condensation and seepage from the wall.

CATEGORY B: INTERIOR EXAMINATION OF WALLS NEAR AND ABOVE GRADE

CASE 12



SYMPTOMS

Damp walls near or below grade.

USUAL CAUSES

Seepage and capillary wicking of groundwater or trapped moisture from the wall above may make the top of the foundation wall damp. Efflorescence deposits are usually left when the moisture dries.

RECOMMENDED ACTIONS

Condition 2:

Infrequently occurring light seepage may be cured by installation of an interior drainage system and interior bond-plaster or cement rendering application for dampproofing and strengthening the wall. This must be done by a specialist contractor (See Note).

Condition 3:

NOTES

When it is impractical to install or repair an exterior foundation drainage system, it has sometimes proven effective to install an interior perimeter drain system similar to Figure 1. The effectiveness of these drainage retrofits is often enhanced when one or more pumped sump pits are also installed in the area of greatest seepage. Minor seepage through the wall can be alleviated by drilling holes through the base of the wall from the inside trench prior to installation of the drain pipe and gravel. Small pipes may be driven into these holes if there is concern that plugging of the drilled holes may subsequently block drainage.

CATEGORY C

EXTERIOR EXAMINATION OF WALLS BELOW GRADE

Cases in this category:

General Notes

Case 1. Uneven wall surfaces requiring preparation

CATEGORY C EXTERIOR EXAMINATION OF WALLS BELOW GRADE

GENERAL NOTES

Thorough examination of walls below grade is possible only after excavation and cleaning of their exposed surfaces. This is usually carried out only for major restorations or repairs to seriously damaged or badly leaking walls.

During initial assessment of a basement for insulation retrofitting, it is advisable to take note of any of the following conditions which may be present:

- Deep area ways, retaining walls, cantilevered supports for decks, door steps or adjoining structures.
- Steeply sloping ground grading towards or away from the basement.
- Large trees, their type, height and distance from the foundation.
- Other shrubbery, plantings or landscaping features which could limit exterior retrofit options or have a bearing on basement conditions and performance.

CATEGORY C: EXTERIOR EXAMINATION OF WALLS BELOW GRADE

CASE 1

SYMPTOMS

Uneven wall surfaces requiring preparation before being covered with membranes, coatings or insulation boards.

USUAL CAUSES

Small ridges or voids left in concrete during forming. Unevenness of rubble, stone or concrete block masonry surfaces.

RECOMMENDED ACTIONS

Condition 2:

Small ridges and projections should be chiselled away and small voids filled with sand-cement grout applied to cleaned and wetted surfaces. Where acrylic latex coating is to be applied, a filled acrylic latex may be used to fill rough surfaces.

Condition 3:

Two or more parging coats or shot-creting may be necessary to fill and level surfaces to receive coatings, membranes or semi-rigid insulation boards. These are usually applied by concrete and masonry specialists.

NOTES

CATEGORY D

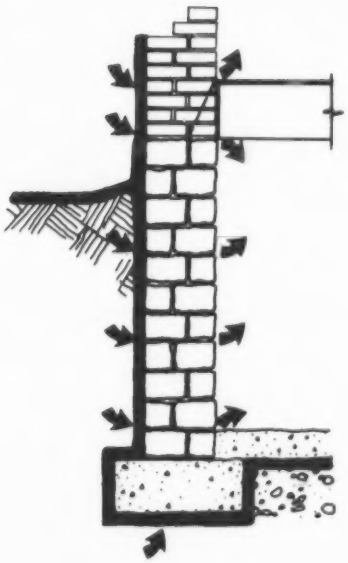
INTERIOR EXAMINATION OF WALLS BELOW GRADE

Cases in this category:

Case 1. Damp walls below grade
Case 2. Horizontal cracks
Case 3. Vertical cracks
Case 4. Diagonal cracks
Case 5. Adhesion freezing and heave

CATEGORY D: INTERIOR EXAMINATION OF WALLS BELOW GRADE

CASE 1



SYMPTOMS

Damp walls below grade.

USUAL CAUSES

Seepage and capillary wicking of groundwater are common problems for poorly drained masonry walls. Condensation occurs on wall surfaces whenever inside surface temperatures are below the dew point of the air.

RECOMMENDED ACTIONS

Condition 2:

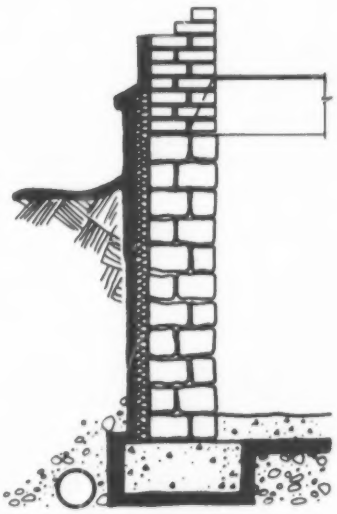
Condition 3:

Heavy seepage and suspected deterioration of the masonry wall will require exterior excavation to the footings, application of a two coat parge and a dampproofing coating, installation of a foundation drainage system, exterior insulation and protective coating (See Note).

NOTES

Crumbling masonry or concrete due to frost action, frequent wetting and drying, and/or large changes in temperature may be aggravated by insulating on the inside. If combined with wood rot or other problems of structural significance, complete structural repair by a specialist foundation contractor must be carried out before any retrofitting is started. Retrofitting on the outside is probably the best option after the repairs have been completed.

Dampness, leakage of water and occasional flooding are problems commonly associated with rubble and stone wall construction. If the basement is to be



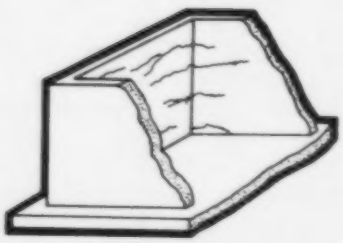
upgraded, excavation to the footing level and parging and dampproofing of the exterior wall face is essential. Surface water must be diverted and foundation drainage ensured in some manner. While such an upgrading task may be unrelated to thermal upgrading, it provides a good opportunity for the installation of exterior insulation.

The application of interior insulation to a rubble wall lacking proper dampproofing or exterior drainage is not advisable, particularly at the wall/joist intersection. The reduction of heat loss to the moisture-saturated walls may cause freeze/thaw damage. If joist spaces are insulated, moisture drawn up through the wall will condense in the joist area and may cause eventual deterioration of the wood.

A two-coat parging applied to a thoroughly cleaned outside surface will provide a good base on which to apply liquid or membrane dampproofing and drainable or impermeable insulation and a new exterior foundation drainage tile system as shown in Figure 1. The final coat of parging must be as smooth and as flat as possible so that the insulation will fit tightly against the wall. Near and above grade, the insulation must be covered with a protective coating, such as cement parging on wire mesh reinforcement, and capped at the top to shed water and prevent infiltration.

CATEGORY D: INTERIOR EXAMINATION OF WALLS BELOW GRADE

CASE 2



Horizontal Cracks

SYMPTOMS

Horizontal cracks.

USUAL CAUSES

Vertical bending of walls may cause long horizontal cracks to open on the inside of mortar joints of masonry or parallel to the direction of reinforcing steel (if any) in cast-in-place concrete. Placing backfill too soon or too high against immature concrete, or placing excessive weight on the backfill too close to the wall are common causes. Expansion of backfill soils due to clay swelling or frost heaving are other causes.

RECOMMENDED ACTIONS

Condition 2:

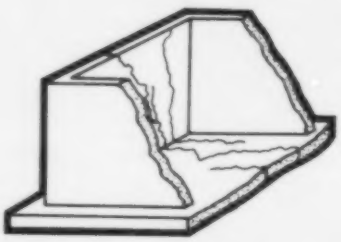
Condition 3:

Nearly all incidences of structural cracking of basement walls should be referred to structural engineers for investigation and planning of remedial action.

NOTES

CATEGORY D: INTERIOR EXAMINATION OF WALLS BELOW GRADE

CASE 3



Vertical Cracks

SYMPTOMS

Vertical cracks.

USUAL CAUSES

Horizontal bending of the walls may cause vertical cracks to open on the inside of basement walls in the direction perpendicular to that of reinforcing steel in cast-in-place concrete. Bowing of the wall can happen if the footing base course and floor slab don't provide sufficient restraint to lateral displacement.

RECOMMENDED ACTIONS

Condition 2:

Condition 3:

A structural/foundation engineer should be consulted with regard to the cause of the bending, and the design of any necessary remedial work (See Notes).

NOTES

Severely cracked and/or displaced foundation walls should be examined by an experienced structural-foundation engineer. The engineer's report should include a rehabilitation design for structural safety and recommendations for drainage and thermal upgrading. Once the structural sufficiency and adequacy of drainage have been assured, crack filling and moisture proofing can be carried out. Cracks which penetrate the full thickness of a foundation wall are best repaired from the outside if a trench can be dug wide and deep enough for access. The wall surface near the crack should be thoroughly cleaned by brushing and washing to remove all dirt and loose material. If the construction is of unit masonry, any loose mortar should be removed to a depth of 18-20 mm, then moistened before repointing

with a stiff cement-sand mortar consisting of 1 part of portland cement to 1 1/2 parts of mortar sand by volume. An acrylic latex bonding agent can significantly improve the mortar. Cracks in concrete or masonry units can be repaired by routing out to a depth of at least 12 mm and a width of at least 18 mm. All loose material and dust must be removed. Various crack fillers or sealants including polysulfide, polyurethane, epoxy, silicone, modified polymer cement or latex modified cement mortars have been used successfully to repair cracks from the outside. The choice of crack repair materials must take into account the compatibility with the materials to be overlaid. For walls with generally poor surface conditions a two-coat parging or a shotcrete resurfacing may be necessary. Special reinforcing and bonding coatings may be used to seal and strengthen walls.

If for economic or other reasons, crack repairs must be made from the inside, the services of a contractor specializing in concrete repair is recommended.

Where expansive clays are used as backfills, horizontal bending and cracking of basement walls may occur suddenly anytime during the life of the structure, or progressively through several cycles of expansion and contraction of backfill soils. Wetting and drying, freezing and thawing and infilling of the cracks between the foundation and the ground may be contributing conditions. In areas such as the Red River Valley of Manitoba and the Regina Plains of Saskatchewan, particularly severe problems due to expansive clay subsoils and backfills are addressed to a certain extent by local building bylaws. Severely cracked or displaced foundation walls should be examined for structural safety, and rehabilitation work should be designed and supervised by an experienced structural/foundation engineer before any retrofitting is carried out.

CATEGORY D: INTERIOR EXAMINATION OF WALLS BELOW GRADE

CASE 4

SYMPTOMS

Diagonal cracks.

USUAL CAUSES

Diagonal tension cracks starting near corners and sloping upward at angles ranging from 30 to 45 degrees may indicate loss of support below footings near the centre of the wall. Conversely, dia gonal cracks sloping upwards towards corners may indicate heaving of the footings near the centre of the wall.

RECOMMENDED ACTIONS

Diagonal Cracks

Condition 2:

Condition 3:

A structural/foundation engineer should be consulted with regard to the causes of the cracks, and the design of any necessary remedial work (See Notes).

NOTES

Severely cracked and/or displaced foundation walls should be examined by an experienced structural-foundation engineer. The engineer's report should include a rehabilitation design for structural safety and recommendations for drainage and thermal upgrading. Once the structural sufficiency and adequacy of drainage have been assured, crack filling and moisture proofing can be carried out. Cracks which penetrate the full thickness of a foundation wall are best repaired from the outside if a trench can be dug wide and deep enough for access. The wall surface near the crack should be thoroughly cleaned by brushing and washing to remove all dirt and loose material. If the construction is of unit masonry, any loose mortar should be removed to a depth of 18-20 mm, then moistened before repointing with a stiff cement-sand mortar consisting of 1 part

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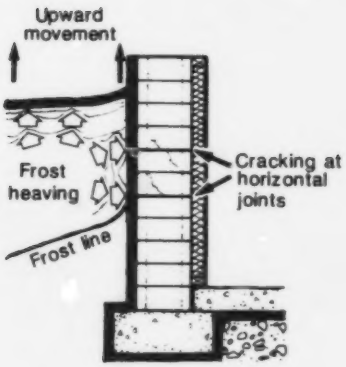
CATEGORY D: INTERIOR EXAMINATION OF WALLS BELOW GRADE

CASE 5



SYMPTOMS

Adhesion freezing and frost heave. Sometimes referred to as adfreeze having.

USUAL CAUSES

The soil and its moisture content may freeze to the foundation. Any vertical expansion of the soil, due to frost or ice build-up, may then be transmitted to the foundation wall, causing horizontal cracks. The latest information is that this is unlikely to occur except under attached unheated structures such as cold garages.

RECOMMENDED ACTIONS

Condition 2:

Condition 3:

A geotechnical/foundation engineer should be consulted with regard to the causes of the damage and the design of remedial measures. The following Note offers suggestions for reducing frost penetration below adjoining unheated structures.

NOTES

Insulated subgrades for adjoining unheated structures such as pavements, sidewalks, and garage floors can often be incorporated in exterior insulation retrofitting designs to gain advantages in energy conservation and reduced maintenance due to seasonal ground movements. The design and the supervision of construction of these insulation systems require the services of an experienced geotechnical/foundation engineer.

CATEGORY E

EXTERIOR EXAMINATION OF WALL FOOTINGS

Cases in this category:

General Notes

Case 1. Deteriorated concrete or masonry
Case 2. Porous zones or open construction joints
Case 3. Cracked or displaced footings and walls

CATEGORY E: EXTERIOR EXAMINATION OF WALL FOOTINGS

GENERAL NOTES

Excavation to expose footings and the base of the foundation walls should also permit thorough examination of the foundation drainage system. If the drainage system is capable of functioning effectively or requires some upgrading, it is advisable to consider a graded gravel or fabric filler addition to the system to ensure long, continuous life.

CATEGORY E: EXTERIOR EXAMINATION OF WALL FOOTINGS

CASE 1

SYMPTOMS

Deteriorated concrete or masonry units in the footings and base of the wall.

USUAL CAUSES

Sulphate attack of concrete can proceed to complete destruction of bonding if sulphate-bearing groundwater has continuously seeped through.

RECOMMENDED ACTIONS

Condition 2:

Major concrete or masonry restoration by a foundation repair contractor under professional direction will probably be required.

Condition 3:

Same as Condition 2.

NOTES

CATEGORY E: EXTERIOR EXAMINATION OF WALL FOOTINGS

CASE 2

SYMPTOMS

Porous zones or open cracks at construction joints between wall and footing.

USUAL CAUSES

Poor construction practices or subsequent deterioration due to sulphate attack, etc.

RECOMMENDED ACTIONS

Condition 2:

Require specialized repair methods and materials by concrete repair and waterproofing contractors.

Condition 3:

Same as Condition 2.

NOTES

CATEGORY E: EXTERIOR EXAMINATION OF WALL FOOTINGS

CASE 3

SYMPTOMS

Cracked and/or displaced footings and walls.

USUAL CAUSES

Ground movements below footing level possibly due to expansion or contraction of clay subsoils, settlement of compressible subsoils, or foundation damage due to excessive vibrations or nearby excavations.

RECOMMENDED ACTIONS

Condition 2:

The services of a professional geotechnical/-foundation engineer should be retained to provide analysis and plan for rehabilitation.

Condition 3:

Same as Condition 2.

NOTES

CATEGORY F

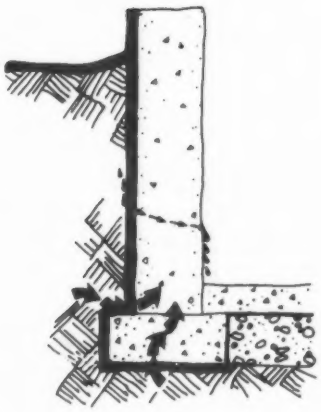
INTERIOR EXAMINATION OF WALL FOOTINGS AND FLOOR

Cases in this category:

Case 1. Wall and footing wicking moisture
Case 2. Water leaks at joint of wall and floor
Case 3. Cracks or holes actively flowing water
Case 4. Deteriorated concrete or masonry

CATEGORY F: INTERIOR EXAMINATION OF WALL FOOTINGS AND FLOOR

CASE 1



SYMPTOMS

Efflorescence deposits, dark colour, dampness and/or breakdown of concrete or masonry.

USUAL CAUSES

Footings and walls without effective dampproofing or capillary-breaking layers can wick groundwater to the lower inside of the wall, causing the observed symptoms.

RECOMMENDED ACTIONS

Condition 2:

Mild forms of moisture wicking with no evidence of deterioration of the concrete may be remedied with various dampproofing paints, coatings or membranes applied to the interior and extended up and down the wall to lengthen the capillary path and to reduce the surface evaporation as much as practicable.

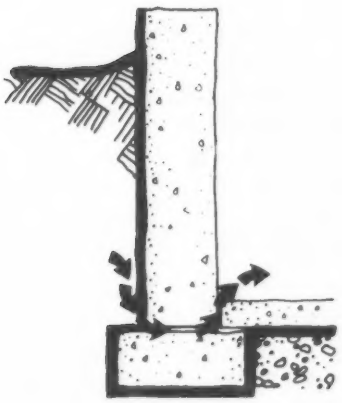
Condition 3:

Severe cases of moisture movement or deterioration of masonry or concrete require the services of a foundation engineer to design restoration.

NOTES

CATEGORY F: INTERIOR EXAMINATION OF WALL FOOTINGS AND FLOOR

CASE 2



SYMPTOMS

Water or moisture leakage at the junction of the wall and floor.

USUAL CAUSES

Overwhelmed, blocked or improperly placed foundation drainage system, with inadequate subgrade gravel and no seal at the footing-wall and the floor-wall construction joints.

RECOMMENDED ACTIONS

Condition 2:

Mild or occasional small leakages may be stopped by caulking the joint between floor and wall.

Condition 3:

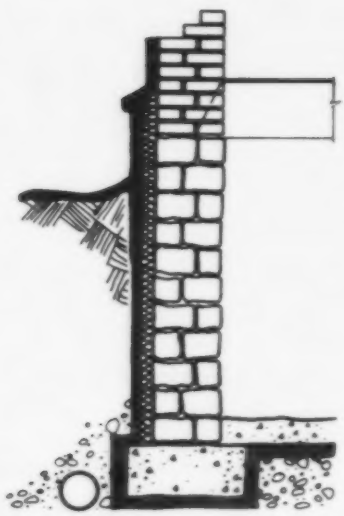
Continuing or large occasional leaks usually can only be remedied with excavation and installation of an exterior waterproofing and improvement in the foundation drainage system, which might include exterior draining insulation (See Note).

NOTES

Crumbling masonry or concrete due to frost action, frequent wetting and drying, and/or large changes in temperature may be aggravated by insulating on the inside. If combined with wood rot or other problems of structural significance, complete structural repair by a specialist foundation contractor must be carried out before any retrofitting is started. Retrofitting on the outside is probably the best option after the repairs have been completed.

Dampness, leakage of water and occasional flooding are problems commonly associated with rubble and stone wall construction. If the basement is to be

upgraded, excavation to the footing level and parging and dampproofing of the exterior wall face is essential. Surface water must be diverted and foundation drainage ensured in some manner. While such an upgrading task may be unrelated to thermal upgrading, it provides a good opportunity for the installation of exterior insulation.

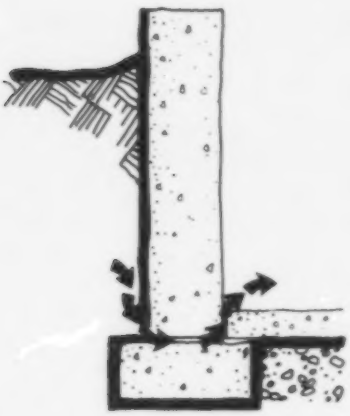


The application of interior insulation to a rubble wall lacking proper dampproofing or exterior drainage is not advisable, particularly at the wall/joist intersection. The reduction of heat loss to the moisture-saturated walls may cause freeze/thaw damage. If joist spaces are insulated, moisture drawn up through the wall will condense in the joist area and may cause eventual deterioration of the wood.

A two-coat parging applied to a thoroughly cleaned outside surface will provide a good base on which to apply liquid or membrane dampproofing and drainable or impermeable insulation and a new exterior foundation drainage tile system as shown in Figure 1. The final coat of parging must be as smooth and as flat as possible so that the insulation will fit tightly against the wall. Near and above grade, the insulation must be covered with a protective coating, such as cement parging on wire mesh reinforcement, and capped at the top to shed water and prevent infiltration.

CATEGORY F: INTERIOR EXAMINATION OF WALL FOOTINGS AND FLOOR

CASE 3



SYMPTOMS

Cracks or holes with actively flowing water.

USUAL CAUSES

Penetration located below the permanent or perched water table.

RECOMMENDED ACTIONS

Condition 2:

Condition 3:

Repair of cracks or holes by injection of epoxy resins, expanding grouts, etc. is a highly specialized technology requiring the services of experienced specialists. The structural capabilities of basement walls to withstand water pressure must be checked by a structural engineer, or drainage provision must be made to prevent any future occurrence of water pressure build-up.

NOTES

CATEGORY F: INTERIOR EXAMINATION OF WALL FOOTINGS AND FLOOR

CASE 4

SYMPTOMS

Deteriorated concrete or masonry.

USUAL CAUSES

Sulphate attack of concrete progressive and completely destructive if moisture continues to move through the concrete.

RECOMMENDED ACTIONS

Condition 2:

Improve foundation drainage and waterproofing on exterior walls and footing surfaces.

Condition 3:

Reconstruction of deteriorated footing and wall areas with rich sulphate-resistant cement concrete by a foundation restoration specialist.

NOTES

CATEGORY G

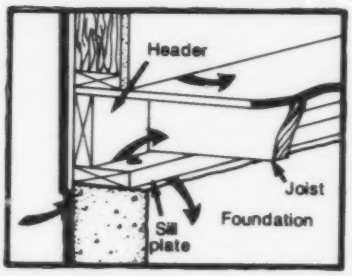
EXAMINATION FOR CONDITIONS CONCEALED BEHIND WALL FINISH

Cases in this category:

Case 1. Excessive air leakage at foundation superstructure joint.
Case 2. Cold floor over foundation wall
Case 3. Frozen pipes
Case 4. Condensation within the wall.

CATEGORY G: EXAMINATION FOR CONDITIONS CONCEALED BEHIND WALL FINISH

CASE 1



SYMPTOMS

Air leakage - excessive infiltration at the foundation superstructure contact.

USUAL CAUSES

Incomplete air barrier.

RECOMMENDED ACTIONS

Condition 2:

If interior finish can be removed only partially, refer to Note. Also, refer to BETT Manual 'Air Sealing Homes for Energy Conservation.'

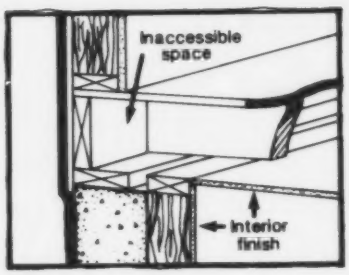
Condition 3:

NOTES

When an incomplete air or vapour barrier is concealed behind interior finish which cannot be removed, it may be possible to install an external air/vapour barrier before retrofitting insulation on the outside. An important rule-of-thumb to follow with vapour barriers is that at least two-thirds (2/3) of the total thermal resistance of a wall assembly must be located on the cold side of the vapour barrier to prevent serious condensation problems.

CATEGORY G: EXAMINATION FOR CONDITIONS CONCEALED BEHIND WALL FINISH

CASE 2



SYMPTOMS

Cold floor over foundation wall.

USUAL CAUSES

Incomplete air barrier or lack of insulation in joist space.

RECOMMENDED ACTIONS

Condition 2:

Exterior sealing to complete air and vapour barriers and exterior insulation as described in Notes. Also refer to the BETT Manual 'Air Sealing Homes for Energy Conservation.'

Condition 3:

NOTES

When an incomplete air or vapour barrier is concealed behind interior finish which cannot be removed, it may be possible to install an external air/vapour barrier before retrofitting insulation on the outside. An important rule-of-thumb to follow with vapour barriers is that at least two-thirds (2/3) of the total thermal resistance of a wall assembly must be located on the cold side of the vapour barrier to prevent serious condensation problems.

Moderate to severe condensation in concealed spaces may be worsened by adding insulation on the inside unless a complete vapour barrier can be assured and air leakage towards cold surfaces completely eliminated. Retrofitting vapour barriers on the outside of the structure and covering these with insulation (providing at least two-thirds of the total thermal resistance of the wall assembly on the cold side of the vapour barrier) is usually the most effective

approach when access from the inside is limited or impractical.

CATEGORY G: EXAMINATION FOR CONDITIONS CONCEALED BEHIND WALL FINISH

CASE 3

SYMPTOMS

Frozen pipes.

USUAL CAUSES

Excessive insulation on warm side of pipes, or excessive infiltration.

RECOMMENDED ACTIONS

Condition 2:

If insufficient space provided between pipes and wall, and if exterior insulation cannot be installed, warm-side insulation must be removed.

Condition 3:

NOTES

CATEGORY G: EXAMINATION FOR CONDITIONS CONCEALED BEHIND WALL FINISH

CASE 4

SYMPTOMS

Condensation within the wall.

USUAL CAUSES

Incomplete vapour barrier.

RECOMMENDED ACTIONS

Condition 2:

See Notes.

Condition 3:

See Notes.

NOTES

When an incomplete air or vapour barrier is concealed behind interior finish which cannot be removed, it may be possible to install an external air/vapour barrier before retrofitting insulation on the outside. An important rule-of-thumb to follow with vapour barriers is that at least two-thirds (2/3) of the total thermal resistance of a wall assembly must be located on the cold side of the vapour barrier to prevent serious condensation problems.

Moderate to severe condensation in concealed spaces may be worsened by adding insulation on the inside unless a complete vapour barrier can be assured and air leakage towards cold surfaces completely eliminated. Retrofitting vapour barriers on the outside of the structure and covering these with insulation (providing at least two-thirds of the total thermal resistance of the wall assembly on the cold side of the vapour barrier) is usually the most effective approach when access from the inside is limited or impractical.